DOCUMENT RESUME

ED 227 209 CE 032 948

TITLE Residential Wiring: Electrical Connections [and] Tools and Equipment.
INSTITUTION Texas A and M Univ., College Station. Vocational Instructional Services.
PUB DATE [82]
NOTE 73p.; For related document, see CE 032 946.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Building Trades; Electrical Systems; *Electric Circuits; *Electricians; Electricity; *Equipment Maintenance; *Equipment Utilization; *Hand Tools; Safety; Secondary Education; Tests; *Trade and Industrial Education; Units of Study
IDENTIFIERS Power Tools

ABSTRACT

Intended for student use, this unit focuses on making good electrical splices and electrical connections, and discusses tools and equipment used in house wiring jobs. Specific areas covered in the connections section are types of splices, solder equipment and supplies, and solderless connectors (plastic caps, split bolt connectors, crimp-type connectors, non-insulated and insulated terminals, screw terminals, and back-wired quick connectors). An essay test on electrical connections is provided, but no answer key is available. The purpose of the equipment section is to help technicians select the proper tools and to indicate safety measures in their use. Contents include informative materials and tests (essays, simple recall, true-false, and matching) on these topics: pliers, screwdrivers, saws, drilling tools and equipment, hammers, soldering equipment and supplies, measuring tools, conduit and pipe tools, fishing tools and materials, test lights, and chisels. A final pictorial-recall test on residential wiring tools is included. No answer keys for any of the tests are available. (YLB)

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Vocational Instructional Services

RW-S1

"RESIDENTIAL WIRING..... ELECTRICAL CONNECTIONS"

As electrical splices and electrical connections are the trouble makers and weak points in an electrical circuit or electrical system extreme care must be taken in making them. The two primary considerations to be observed when making electrical splices and electrical connections are that they must be mechanically secure and electrically secure. Therefore, making good electrical splices and good electrical connections are the most important things that new electricians must learn.

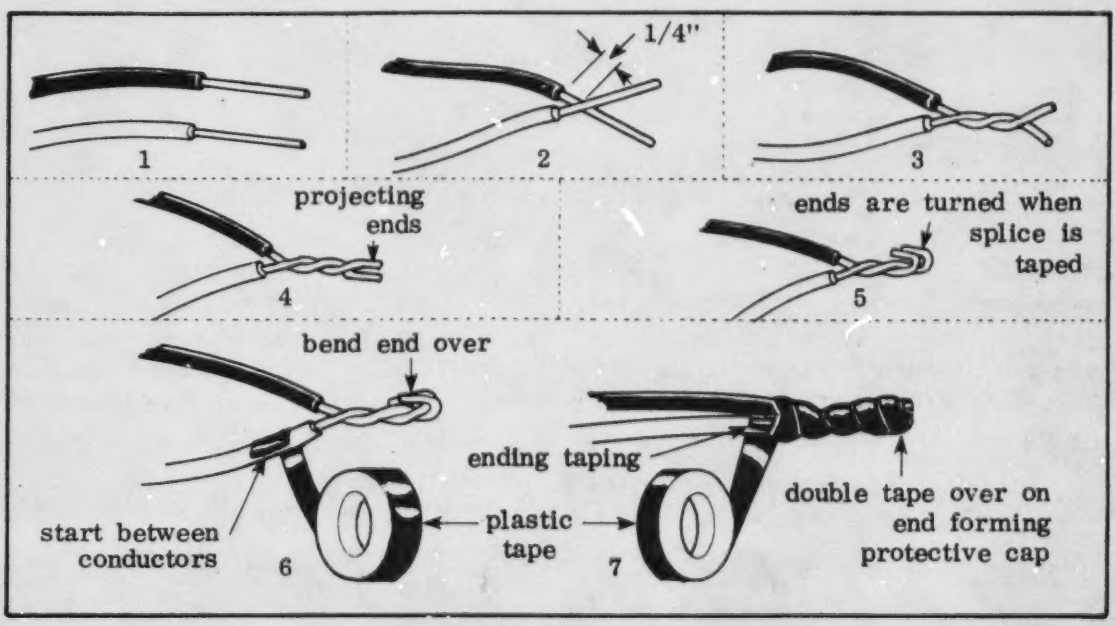
TYPES OF SPLICES

Electrical Splice: Joining the ends of two wires or cables either by mechanically twisting them together or by using a special splicing device.

Pigtail Splice: Three types - taped, two wire solderless, multiple wire solderless

The pigtail splice is the simplest to make. Therefore, it is very likely that it is the most often used electrical splice.

TAPED PIGTAIL



1. Insulation is removed from both wires back an equal distance from the ends, approximately one inch.

2. Cross the wires approximately 1/4" from the end of the insulation.

3. Hold the wires in position with the thumb and fingers of one hand and using pliers in the other hand twist the ends together firmly for approximately six turns. This insures that wires are fastened together properly.

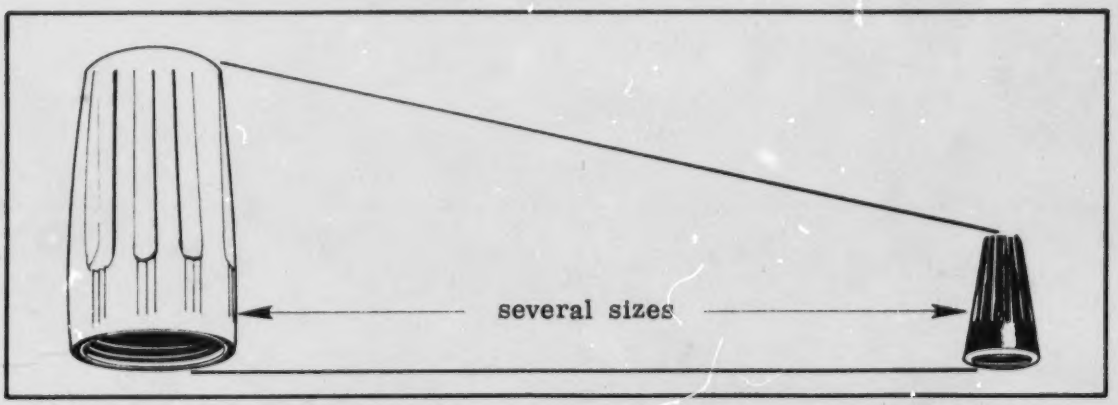
4. After the wires are twisted together there will be protruding ends.

5. Before splice is taped the projecting ends are turned back to prevent them from protruding through the tape.

6. This illustrates the usual method for starting the tape on a splice.

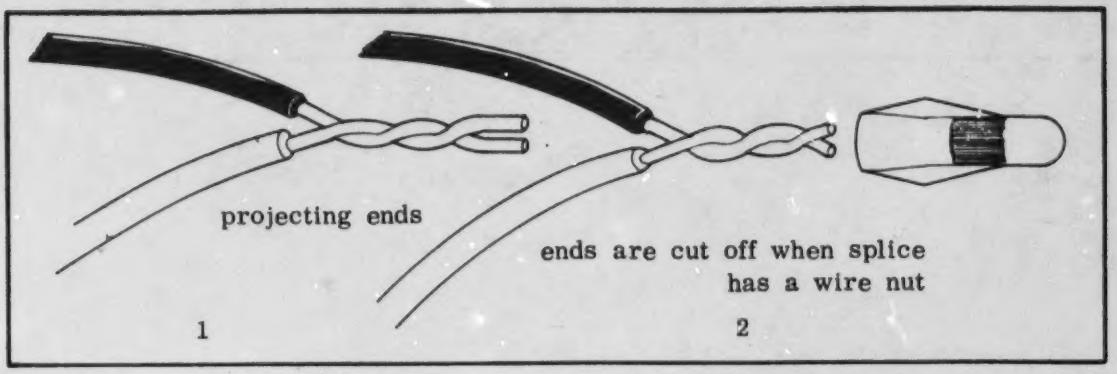
7. Taping is necessary to prevent oxidation of the splice, as well as shocking, and possibly shorting out. The tape is to provide as much insulation as the original insulation. One wrap will take care of voltage up to 600 volts, but in order to obtain good mechanical protection two or more wraps are necessary. Plastic tape is stretched as it is applied in order to secure the tape more firmly.

WIRE NUTS



Also known as a solderless connector. These connectors can be purchased in different colors for coding such as yellow, red, gray, and blue. These connectors have almost completely replaced soldered and taped splices of some types. Solderless connectors are selected for size depending upon the size wire to be joined and the number of wires to be joined. They are used a great deal for electrical splices in outlets and junction boxes. The wire nut has a spring inside and as it is screwed onto the splice it holds the spliced wires more firmly together.

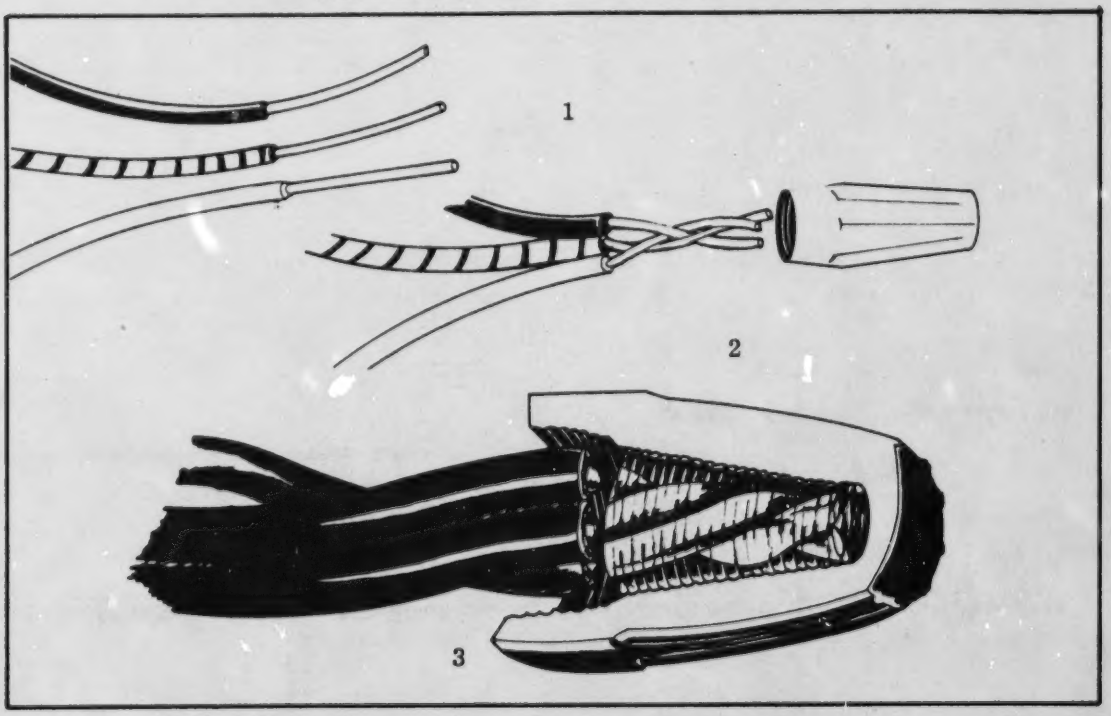
WIRE NUT SPLICE



1. The wire nut pigtail splice is prepared exactly like the taped pigtail up to the final step.

2. The final step consists of cutting off the projecting ends and installing the wire nut or solderless connector.

MULTIPLE-WIRE PIGTAIL SPLICE

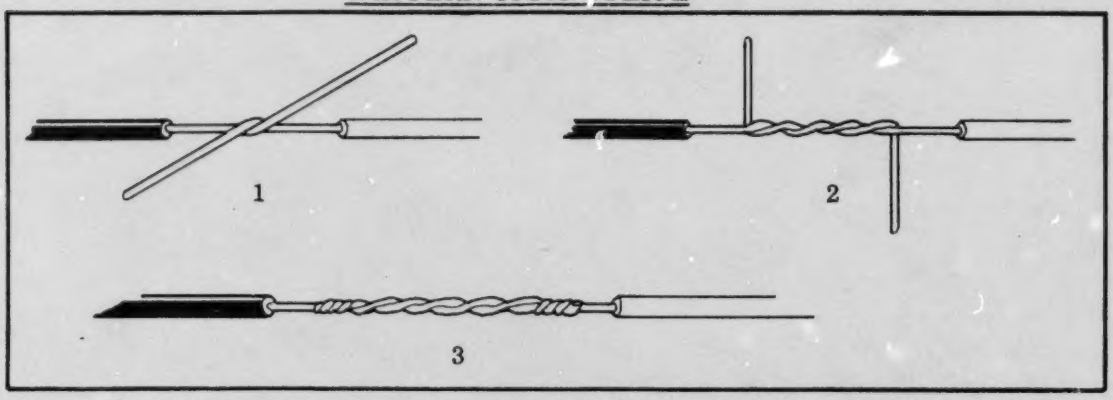


1. Depending on the size of the wires to be spliced remove insulation.

2. Twist the wires together securely; this will insure that all wires are properly fastened together.

3. Ends of wires are clipped and the insulated cap is firmly installed. Make sure that the bottom end of the cap fully covers the insulated area of the wires.

WESTERN UNION SPLICE



The Western Union splice is used when solid conductors must carry their own weight for a considerable span or when the conductors are too large for a pigtail splice. Also, the Western Union splice is used for mechanical efficiency such as where a substantial amount of strain is placed on the connection.

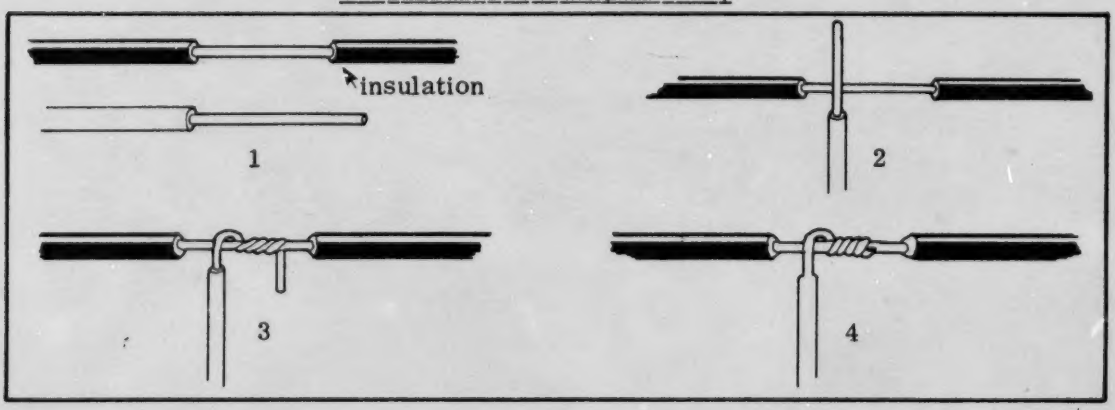
A Western Union splice is prepared by:

1. Removing the insulation from the wires back a distance from the ends depending on their size. The removal of insulation varies from about 3" for no. 14 AWG to approximately 6" for no. 10. The wires are then crossed at their mid points.

2. The ends are then twisted in opposite directions for from four to six turns.

3. The ends are then twisted at right angle to the run of the splice for three full turns. Carefully cut off the excess ends removing any sharp edges.

TEE TAP SPLICE (T - TAP)



The tee tap splice is used to connect one wire to a continuous run of another wire. It is made without having to cut the continuous run or main line. It is somewhat more difficult to make than other types of splices; therefore, it may take an amount of

practice to prepare a neat looking mechanically sound tee tap splice.

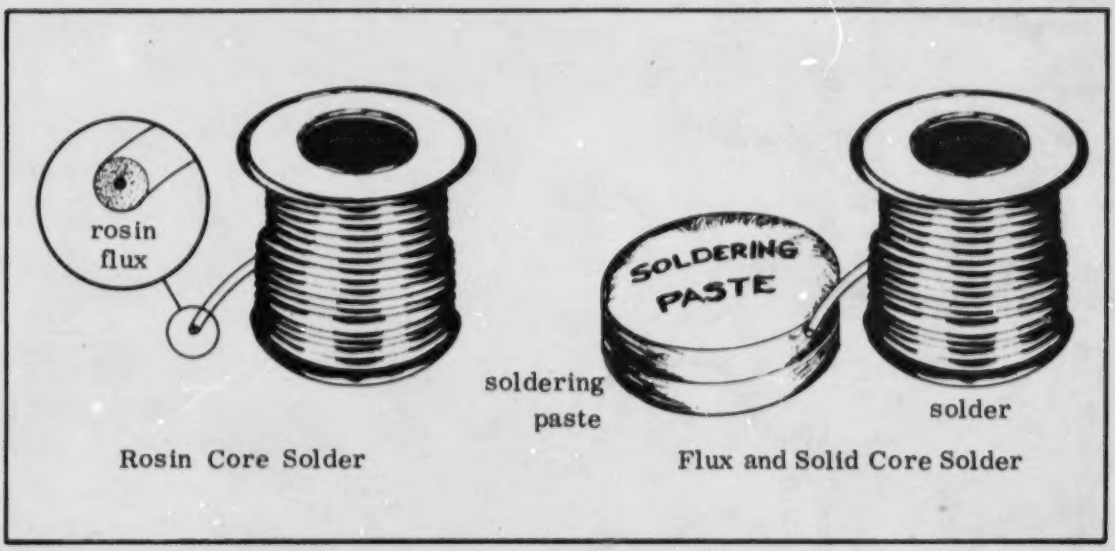
As an example, the tee tap splice is to be made using no. 14 wire.

1. For the tee tap splice insulation on no. 14 wire: Tap wire insulation is removed back from the end for approximately 2", and the ongoing run wire insulation is removed for approximately a distance of 1 1/4".

2. The wires are crossed with the tap wire 1/4" from the insulation at the left on the run wire. The tap wire insulation is to clear the run wire by 1/4".

3. The tap wire is twisted around the run wire drawing each turn tight by using pliers. Make four to five turns with the tap wire. Trim the end leaving no sharp edges.

SOLDER EQUIPMENT AND SUPPLIES



Solder

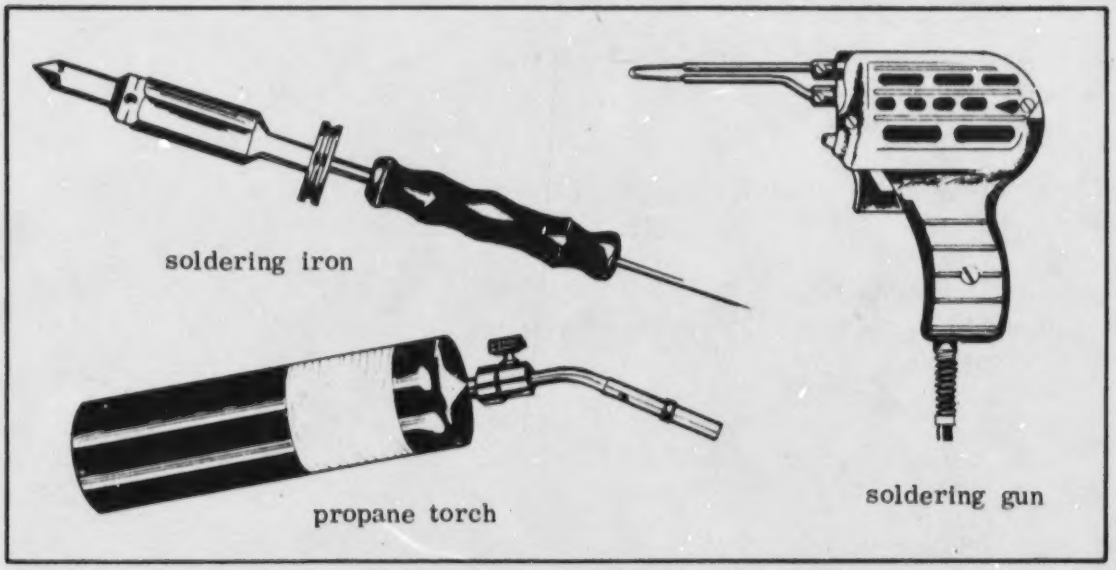
Solder used for electrical work is an alloy of tin and lead. The tin in the solder is for strength and the lead content determines the solder melting point. Various combinations of these metals can be obtained; however, the two most commonly used are 50/50 grade and 60/40 grade. The 50% tin and 50% lead requires less heat for melting, but it makes a stronger joint.

The most common types of solder are rosin core, solid, and acid core. Acid core is not to be used for electrical work as it will corrode the connection.

Rosin core solder has the flux in the hollow core of the string. For most small jobs the rosin core solder is preferred because of the everpresent flux.

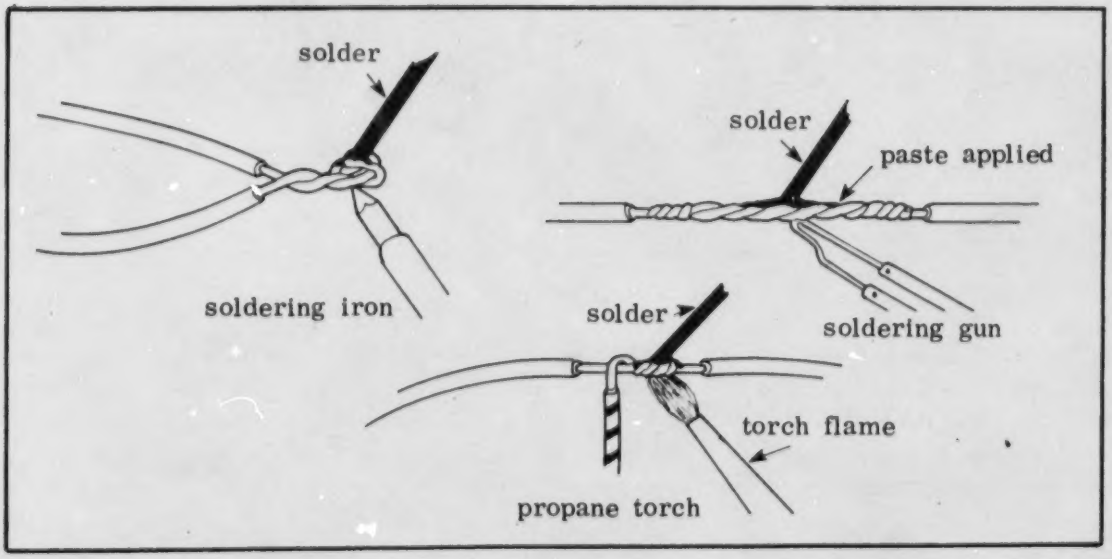
Solid core solder contains no flux. A cleaning flux must be used with it.

HEAT SOURCES



In order to solder there must be heat applied. This heat can be provided by any one of three ways: soldering iron, soldering gun, or propane torch. When electric power is not available the propane torch is used or when the wires are large.

SOLDER SPLICES



Soldering is the most reliable method of joining wires. It does require a certain amount of skill; therefore, practice is necessary. A good solder joint requires a clean metal surface free of foreign particles of dirt, grease, oil, and rust. Thus

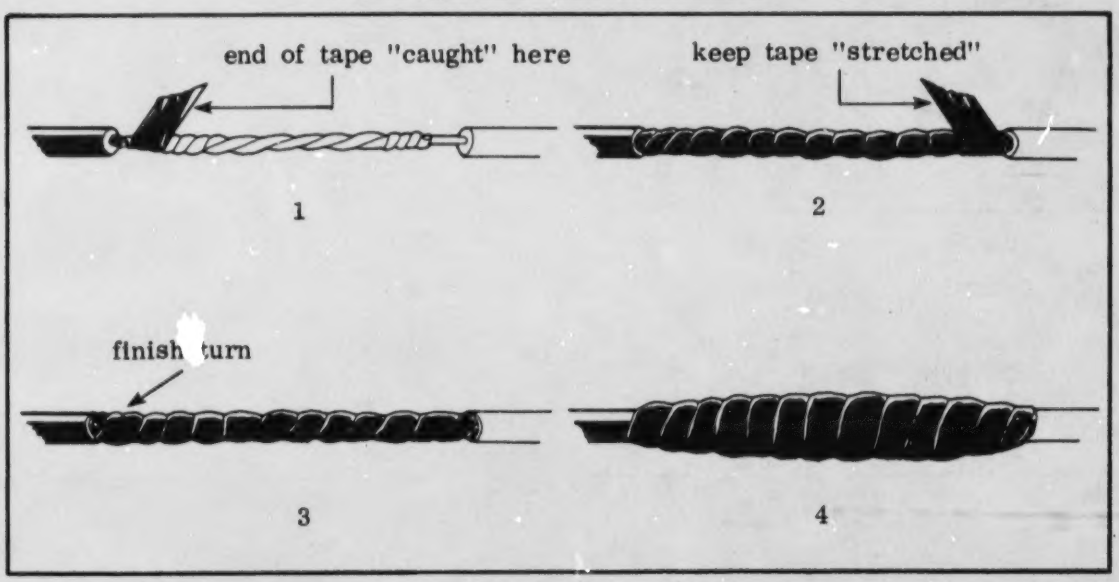
when an area to be soldered has been stripped of insulation and the splice made, it should be soldered as soon as practical, reducing the chance of collecting foreign particles and oxidation which reduces the chances of getting a good solder job.

Cleaning a splice is accomplished by using fine sandpaper, emery cloth, or fluxing it as it is heated. The cleaner a splice the better solder will flow around it.

Heat is always applied from the bottom side or opposite side of a splice from which the solder is applied. Melting solder flows toward heat. If the top of the splice is hot enough to melt the solder the hotter bottom side will draw the solder down through all the cracks, crevices, and holes in the splice.

A soldered splice is allowed to cool naturally; also, keep from moving the soldered splice. Soldered splices are not to be quenched with water or blown on to cool them. Fast cooling of a soldered splice removes all the strength from the solder and the splice is then mechanically unsound.

TAPE WESTERN UNION SPLICE



Taping of splices can be done by either one of two accepted methods. The purpose of taping is to insulate the splice by covering it with protective material which provides approximately the same electrical strength as the insulation on the original wire. One method of taping is with rubber and friction tape. This is a good method but time consuming, more expensive, and more bulky. Therefore, in recent years plastic tape has come into general use because of its labor saving and being less bulky.

1. Start tape at left end of splice making one turn securing tape. Maintain a pull which will stretch the tape.

2. Wrap the splice to the right in a diagonal pattern keeping the tape stretched. Overlap each preceding turn by one-half the width of the tape.

3. Reverse the direction of travel at the right end of the splice. Continue wrapping the second layer until it is completed.

4. Overlap the tape one-half its width over the left side insulation and wrap back to the right covering the right side insulation by one-half the width of the tape.

   Cut off excess tape and pinch ends against the splice. Remember to keep tape stretched at all times which secures the tape more firmly.

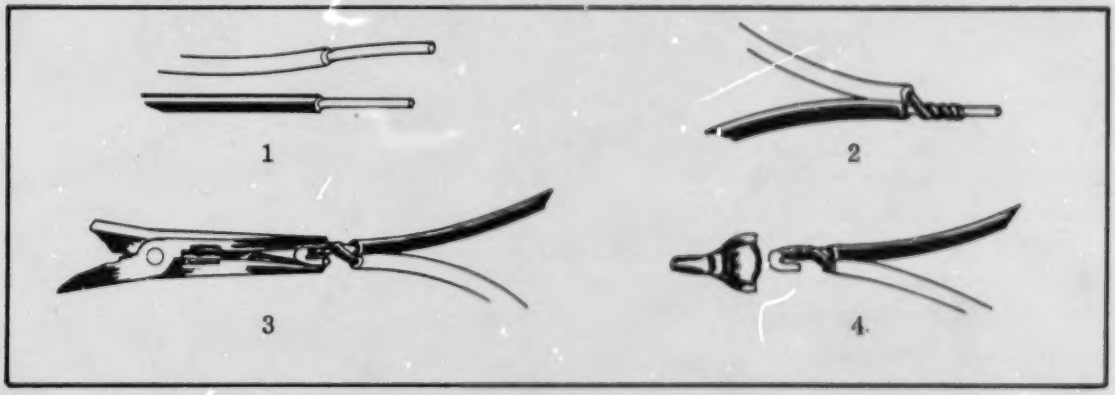
SOLDERLESS CONNECTORS

PLASTIC CAP - Same Gauge and Typewire

1. Wires are stripped, twisted, and cap slipped over connection.

2. Connection is taped by lapping tape over insulation one-half width of tape. Make one loop stretching tape tight. Make diagonal loops covering each loop with one-half width of tape. Tape to center of plastic.

PLASTIC CAP - Different Gauge and Typewire



This type electrical connection is very similar to the same size and type wire connection; however, there is some slight difference.

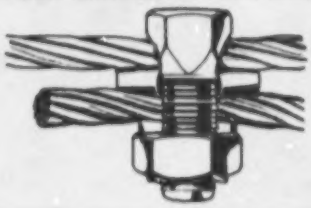
1. Insulation is removed according to size of wires, stranded and solid.

2. The stranded wire is then twisted around the solid wire leaving an exposed end of the solid wire.

3. The exposed end of the solid wire is then bent back over the stranded wire.

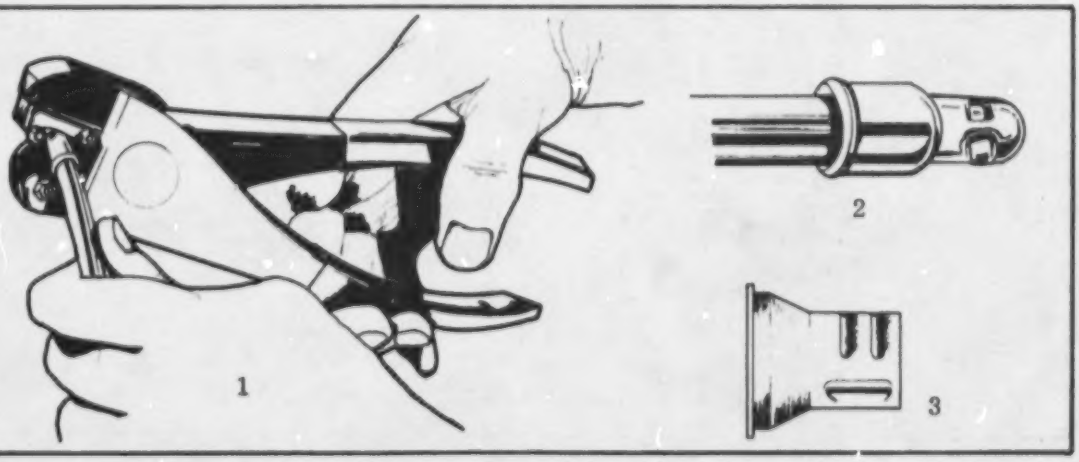
4. A plastic cap is then fitted over the connection.

SPLIT BOLT CONNECTOR



This mechanical connector is used to join cables of large size such as service entrance and the like. The split bolt has a floating separator. This is to keep the cables separated for more secure tightening. The nut and separator are removed from the bolt. The bolt is then slipped over one cable and separator is then inserted. The split bolt is then slipped over the second cable and the nut finger tightened on the bolt. Two wrenches of the correct size are then used to pull the nut down attaching the two ends of the cable securely.

CRIMP - TYPE CONNECTORS



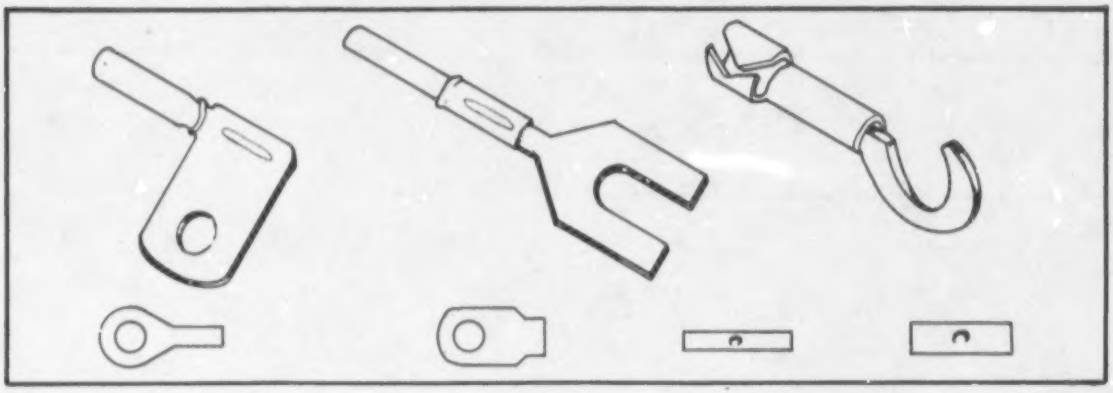
To install this connector:

1. The wires are first stripped and twisted together. The metal cap is then slipped over the wires. A crimping plier is used to crimp wires and thimble together.

2. Figure 2 shows the crimp marks made in the thimble and the three parts firmly locked together.

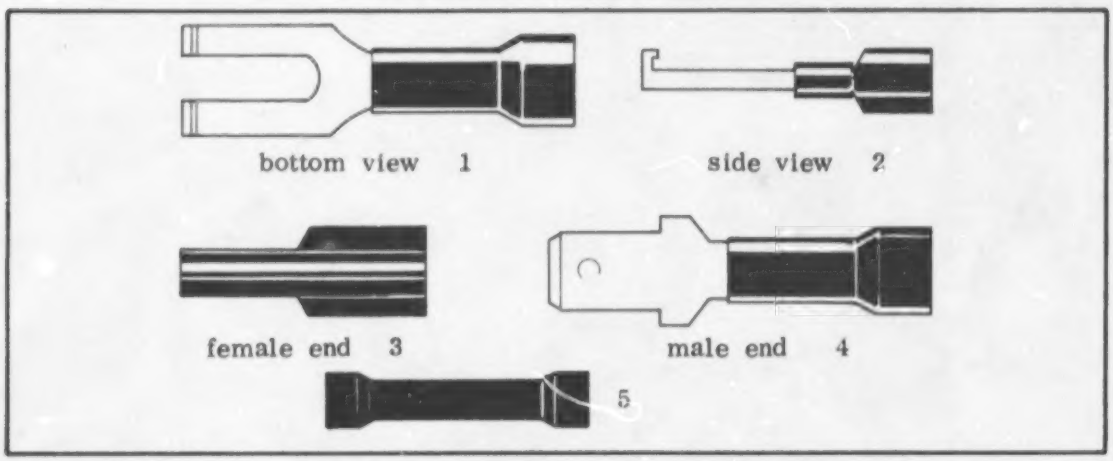
3. The connection at this point can be taped or a vinyl insulating cap can be slipped over the metal thimble.

NON-INSULATED TERMINALS



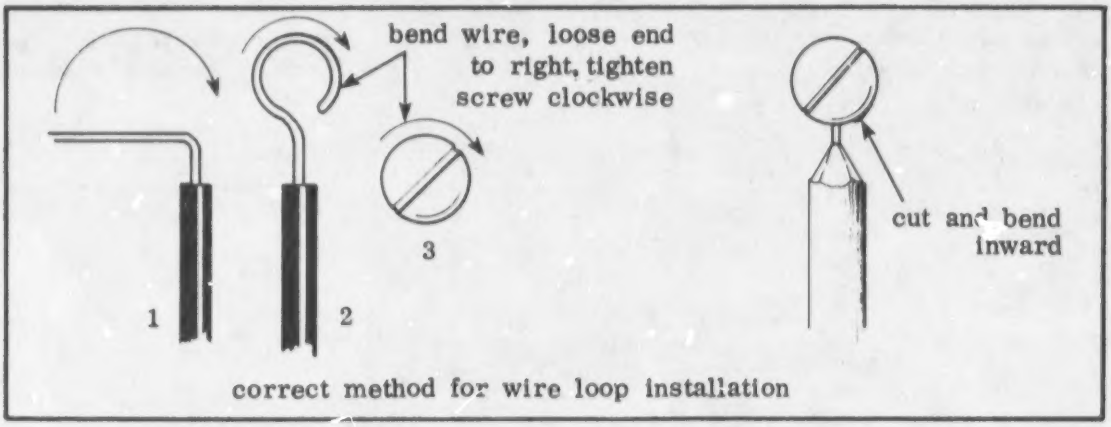
These connectors have for the most part replaced small lugs which are soldered to the wire. Some are crimped by special tools while another is simply closed firmly around wire insulation. Stripped wire is inserted into the hollow end of the connector making sure that insulation is jammed securely against the connector. The non-insulated connector is less expensive and is used in those places where there is no danger of the connection shorting to a metal surface. These connectors can join wires by inserting a wire into each end or as a terminal end for a screw connection.

INSULATED TERMINALS



The insulated connectors are used essentially the same as the non-insulated. However, they can be used in places where otherwise there would be a chance for a short. Figures 1 and 2 show a type connector with the ends turned at a right angle. This helps to lock the connector in position and will withstand a certain amount of strain or pull from the wire. Figures 3 and 4 show the male and female connectors for a quick couple. Figure 5 is the insulated example of a line connector.

SCREW TERMINALS



correct method for wire loop installation

Screw type terminals provide an electrically - mechanically secure connection. In order for this connection to make up properly, however, the wire must be bent and secured with the screw.

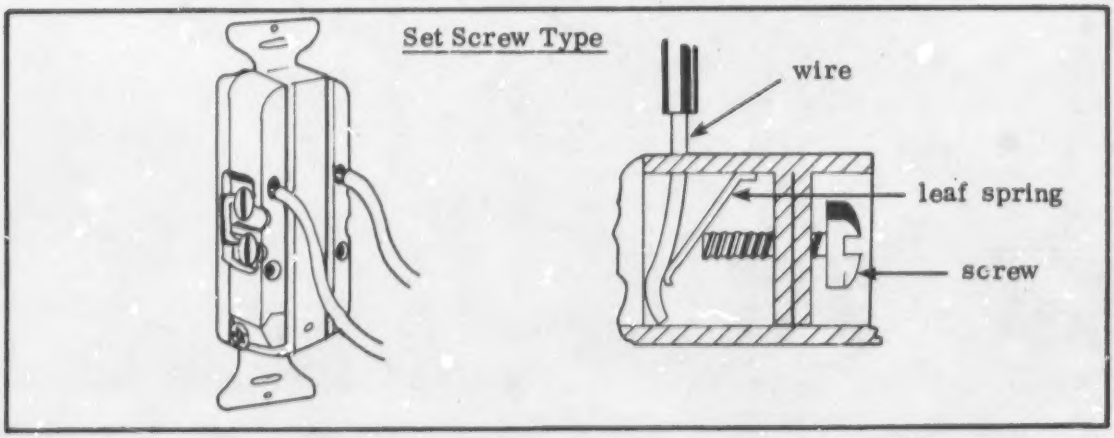
1. The insulation is stripped and the naked wire bent to the left.

2. Using needle nose pliers a near perfect loop is made in the naked wire just larger than the screw over which it is to fit.

3. The wire may be installed on the screw one of two ways:
   a. The loop is not closed and the open end to the right. Slide the loop under the head of the loosened screw. Cut off excess end of wire. Bend end inward, under screw head if possible. Tighten screw firmly.
   b. Close the loop, remove screw, insert screw through loop with open end of securely.

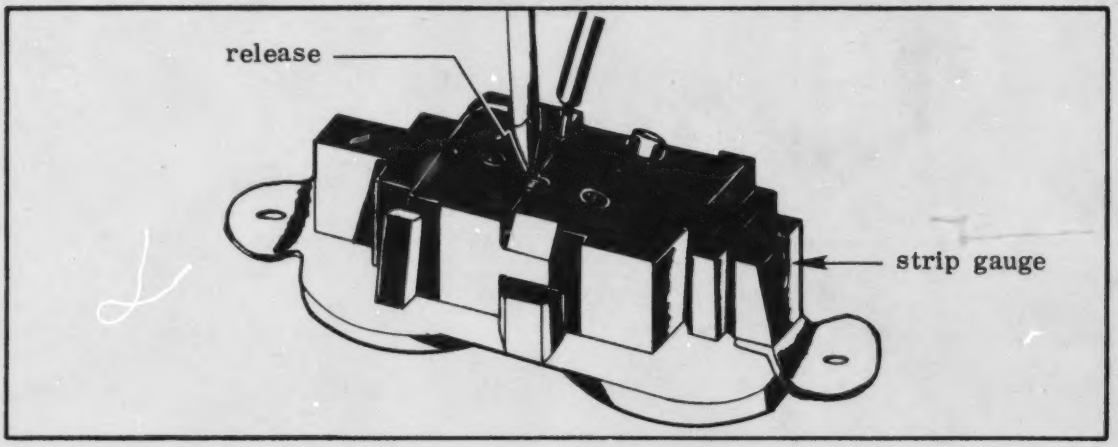
NOTE: Make sure wire end is looped.
Make sure wire end is not too long.
Make sure loose end of wire is under screw head.

BACK - WIRED QUICK CONNECTORS



The set screw type is used by first loosening the set screw, and the skinned wire end is pushed through a hole and behind the spring. Tension is then placed on the spring, which holds the wire in place, by the set screw. To remove the wire the procedure is reversed.

SPRING TYPE



The spring type Back Wired Connector has leaf springs or pressure plates which are actuated by coil springs to hold the conductor wires in place.

On one end of the electrical equipment there is a gauge for the technician to use for determining the amount of insulation to be stripped from the wire.

Circuit wires are inserted into the electrical equipment through holes in the back side.

The conductors are released by inserting a screwdriver or stiff wire into the actuating spring opening next to the particular wire or wires to be removed and pressing down.

ESSAY TEST
ON
ELECTRICAL CONNECTIONS

Directions: Below are questions that are to be answered in complete sentences and in as few words as possible. The test is designed to include correct spelling and use of the correct trade terms.

1. What are the weak points in an electrical system?

2. What are the primary considerations to be observed when making an electrical splice or electrical connection?

3. Define electrical splice.

4. What are the types of "Pigtail" splices?

5. How do the "Pigtail" splices differ?

6. Why is it necessary to tape a splice?

7. Up to what voltage will one wrap of plastic tape take care of?

8. Why stretch plastic insulation tape as it is applied?

9. Where in an electrical system are wire nuts (solderless connectors) most commonly used?

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10. How are wire nuts selected for the job?

11. What are the existing conditions under which an electrical system requires that a "Western Union" splice be used?

12. How is a "Tee" splice made?

13. For what purpose or purposes are "Tee" splices used?

14. What does the expression 60/40 mean, when referring to solder?

15. What is the purpose of the tin content in solder?

16. What are the sources of heat for soldering splices?

17. Why is the source of heat for soldering a splice applied to the opposite side away from the solder?

18. What is the source of soldering heat when electrical power is not available?

19. What are the methods used for cleaning a splice prior to soldering?

20. What is the effect of cooling a solder joint too rapidly?

21. What is the purpose or purposes for taping a splice or connection?

22. For what is a split bolt connector usually used?

23. How does a split bolt connector operate?

24. What is a crimp type connector?

25. When are "Non-Insulated" Terminals used?

26. What is the procedure for preparing a screw terminal correctly?

27. What is the advantage of "Back-Wired" connectors?

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RESIDENTIAL WIRING....
....TOOLS & EQUIPMENT

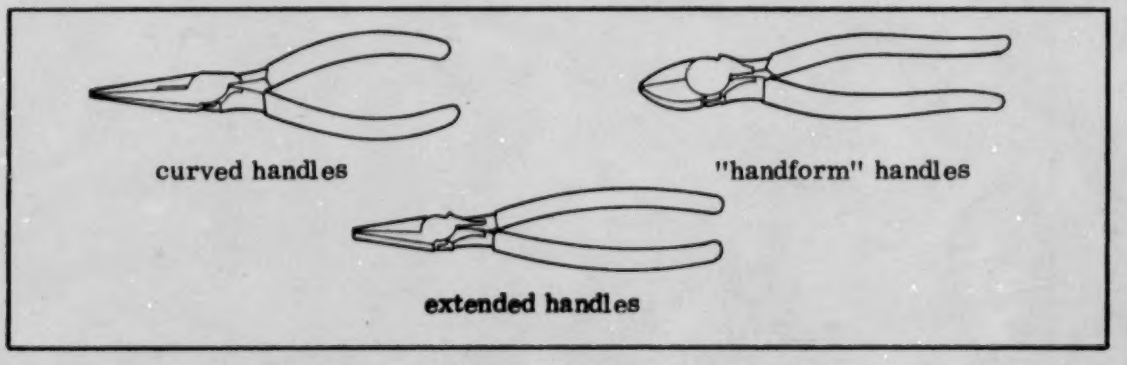
The tools discussed and illustrated in this unit are those used in house wiring jobs. The purpose for this unit is to help a technician select the proper tools, indicate safety measures in using these tools, their use, and maintenance.

In order to perform a good job a technician must have good tools in good working order. But do not expect the tools to do the job, because the tool will do no better job than the user. Quality tools will last much longer and will consistently provide good results. Quality tools will cost more at the outset, but this will offset the repeated replacement of cheaper tools, mistakes, down time from breakage, and waste of materials.

A professional takes the job and personal tools seriously. Each type tool needed for the trade is purchased because this investment will pay off continuously in saving time and giving professional results.

PLIERS

HANDLES



There are three basic types of handles for pliers as indicated in the preceding illustrations. Each type is designed for maximum comfort and efficiency.

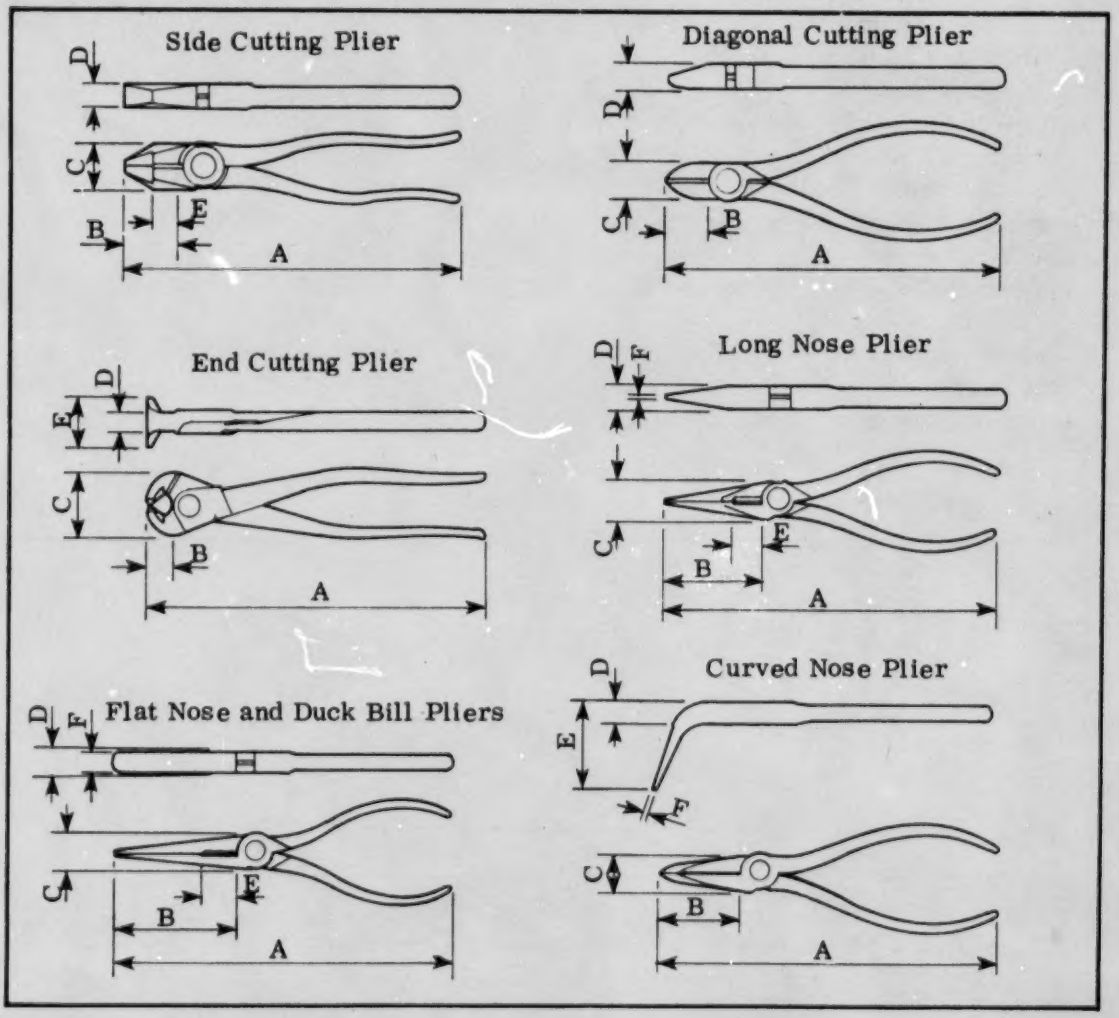
1. Curved handles on pliers are for greater control over the tool, such as cutting, bending, looping, and forming wire.

2. Handform handles are shaped to fit the hand; this gives the plier user a fuller grip and allows for more cutting power.

3. Extended handles provide for a longer reach of the plier and provide increased leverage.

Handles may be bare, dipped and coated with plastic, or insulated. Plastic coated handles are for comfort NOT for electrical shock protection. Even though handles are insulated this is only a secondary precaution against shock and should not be considered sufficient protection, and other safety measures must be exercised at all times.

DIMENSIONING PLIERS

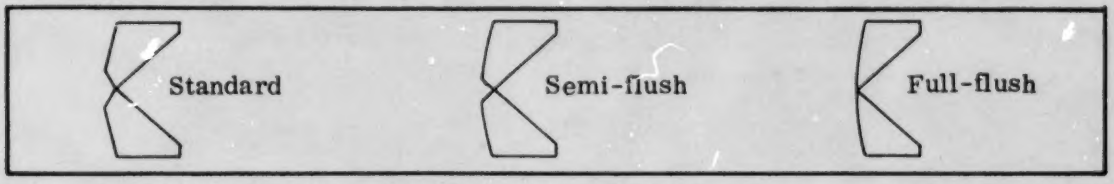


The letters as indicated on the drawings are keys to the dimensions of pliers. Only six types of pliers are illustrated with applied dimensions above. However, other pliers are dimensioned in a like manner.

a. Overall Length
b. Jaw Length
c. Jaw Width
d. Jaw Thickness
e. Knife Length (Cutting Edges)
f. Point Thickness

These dimensions are most helpful to the technician when selecting pliers for the trade.

CUTTING KNIVES



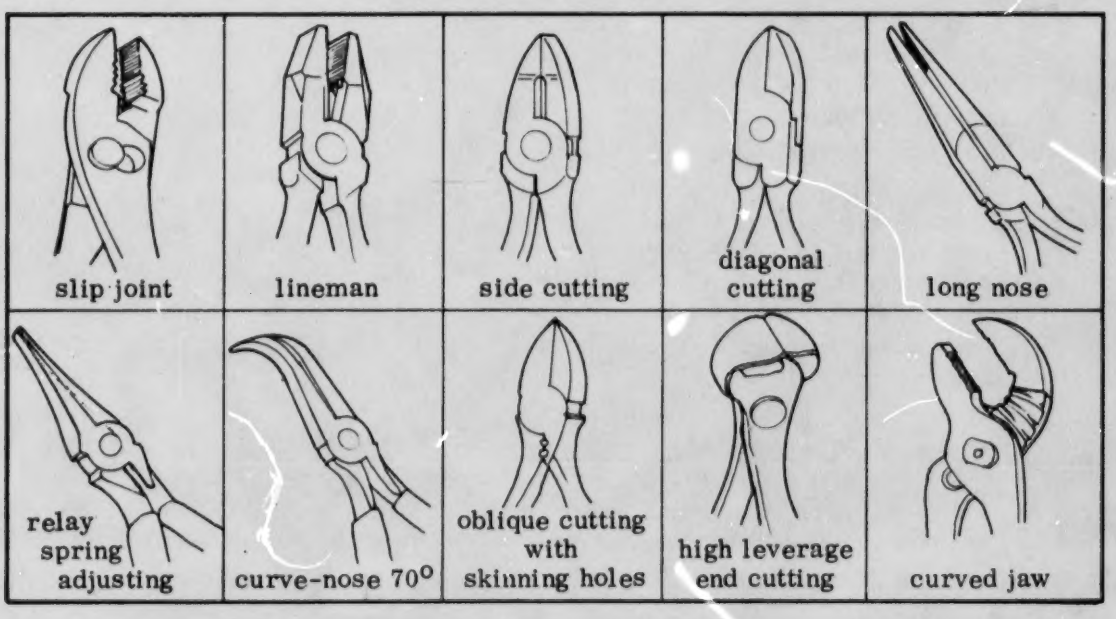
The preceding illustrations depict three types of knife edges for cutting pliers. Each type is designed to make a specific kind of cut in wire and for a certain general degree of wire hardness.

Standard cutting knives are used to cut hard wire.

Semi-flush cutting knives are for close cutting wire of a medium hardness.

Full-flush cutting knives make a close, flat cut of soft wire only.

TYPICAL PLIERS USED FOR HOUSE WIRING



Plier Maintenance

The repairing of pliers is not recommended. Any plier which is cracked, broken, sprung, or having cutting knives that are nicked should be done away with and replaced with a new pair. Cutting knives are sharpened with a small medium-grade hone. Knurls inside plier nose (gripping surfaces) are cleaned with a wire brush. The plier hinge is oiled on occasion with a drop of oil; this helps preserve the tool and assures easy operation.

Plier Use Rules

1. Pliers are not used in the place of another tool. They are NOT: hammers, pry bars, or wrenches. Using them for other than their specified job can damage: the pliers, the work, the user, as well as cause loss of time.

2. Pliers are not to be pushed beyond their intended capacity. They can be sprung or broken if too light a plier or the tip of a needle nose plier is used to attempt bending stiff wire. For this job use a strong blunt nose plier. Cheaters (handle extensions) are not to be used to extend the length of plier handles. If greater leverage is needed, select a plier that gives greater leverage.

3. Pliers are not to be exposed to excessive heat. Heat and direct flame will ruin a plier by drawing the metal temper. Cutting pliers are exceptionally vulnerable to excess heat and direct flame.

4. Hardened wire is not to be cut with ordinary pliers. Hardened wire is to be cut with that plier that is recommended for this job.

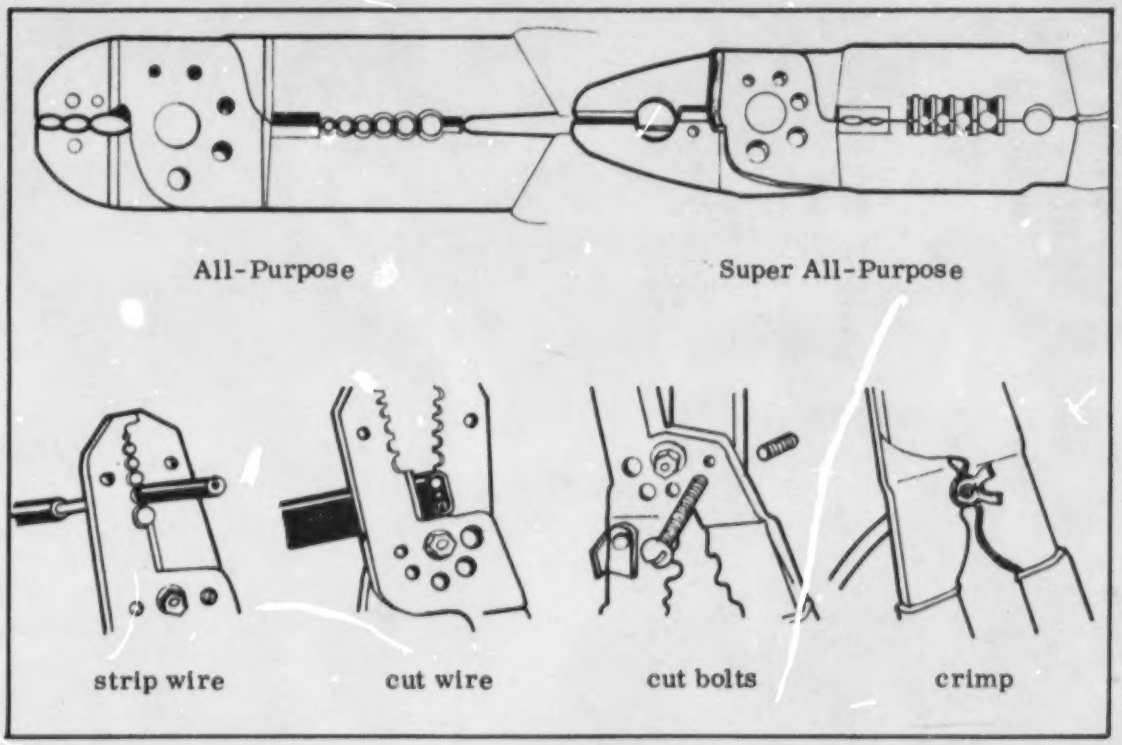
5. Pliers are not to be rocked from side to side to cut a wire, neither is the wire to be bent back and forth against the knives. This practice can spring, dull, or nick the cutting edges. Wire is to be cut at a right angle only. If a plier will not cut through a wire readily, the knives may be dull, or perhaps a plier of greater leverage is needed.

6. Wear goggles, safety glasses, or face shield for the task of cutting wire or any other metal. Be safe! Eye protection devices are an absolute must. It is easy to forget them -- It is a big bother to put them on --especially for just one little cut. No excuse makes sense when eyes are at stake. Any reason or excuse for not wearing eye protection is the lazy person's way of doing things. The professional is always safe.

7. Before cutting metal or wire be sure co-workers are safe. Be considerate of their eyes and well being. Cooperation among workers is a must. The piece of wire or metal that did not get you may just get somebody else. So think about the other person as well as self.

8. Plastic-dipped handles are not insulation against electrical shock. This material on a handle is for comfort and a better grip on the tool. The plastic is not intended for protection against electricity.

MULTIPURPOSE TOOL



These tools vary in size and numbers of tasks they will perform. The all-purpose tool illustrated will shear bolts, cut wire, strip wire, measure stud sizes, gauge wire sizes, and crimp insulated terminals. The super all-purpose tool does the same tasks including crimping non-insulated terminals, crimps lugs, and crimps splices. Wire cutter in the nose will cut 10 to 22 AWG.

ESSAY TEST
ON
PLIERS

Directions: Below are questions that are to be answered in complete sentences and in as few words as possible. The test is designed to include correct spelling and use of the correct trade terms.

1. What are the advantages of selecting and buying quality tools?

2. Pliers are usually designed with three types of handles. What is each type handle designed for?

3. What are the type handles that pliers are equipped with?

4. Which type handle gives greater control over a plier?

5. What plier handle gives the user a fuller grip and allows for more cutting power?

6. What is the purpose of the plastic coating on a plier handle?

7. What are the dimensions to be considered when selecting a plier to purchase?

8. Plier cutting knives are manufactured in three general types. Which type should be selected to make a flush cut of soft wire?

9. What is the usual procedure if a plier needs major repair?

10. What is the usual procedure for plier maintenance?

11. What can be the results if a plier is used in the place of another tool?

12. What is meant by pushing pliers beyond their capacity?

13. What happens to pliers when they are exposed to excessive heat or direct flame?

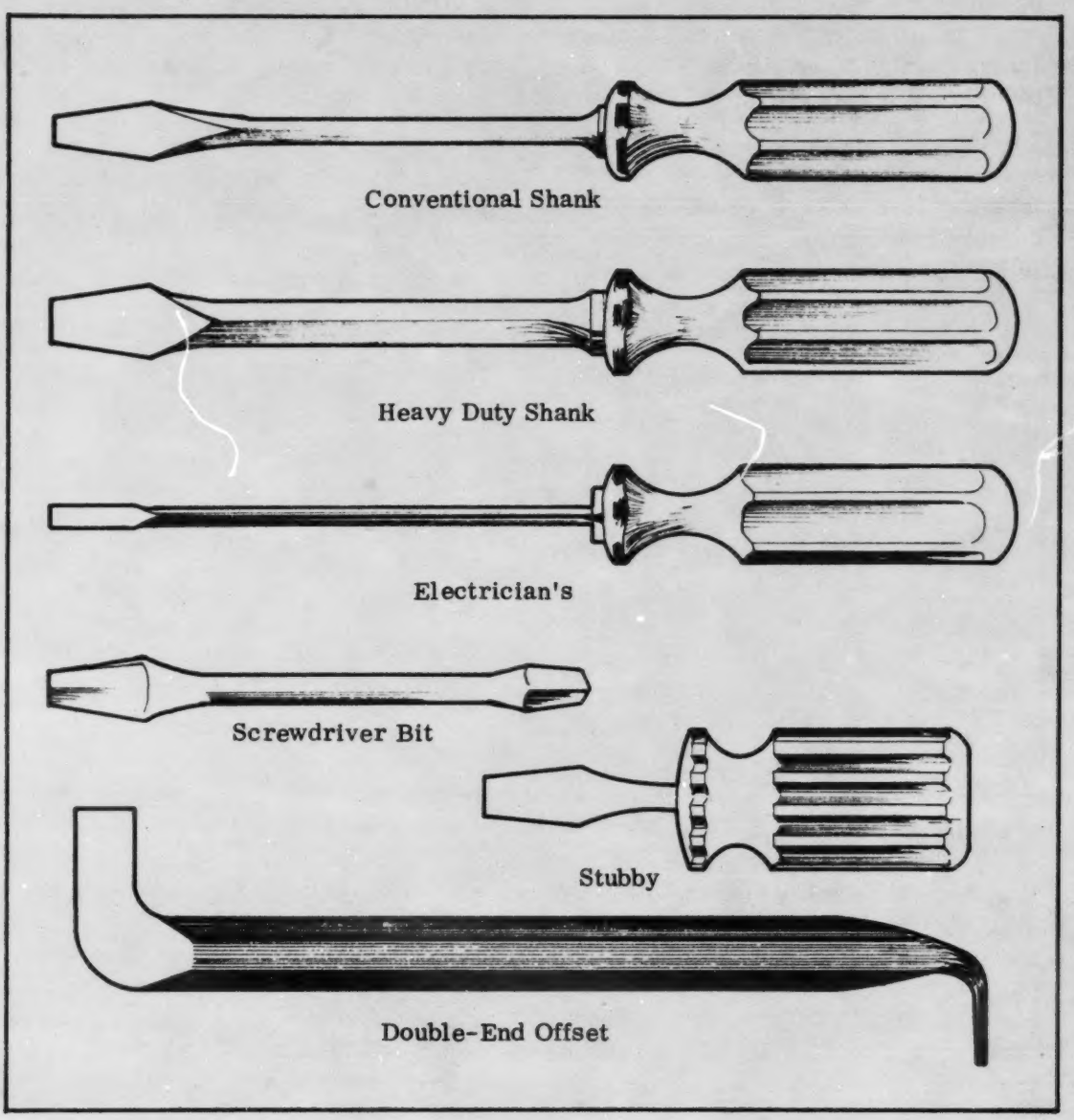
14. If a plier will not cut through a wire readily, what are the usual causes?

15. What are the tasks that can be performed with multipurpose tools?

SCREWDRIVERS

The two most used screwdrivers are the standard blade and the phillips head. These screwdrivers vary in length, shank diameter, and head or blade size. The tool ends are heat treated for necessary hardness and toughness to withstand the pressures put upon them.

STANDARD BLADE SCREWDRIVER

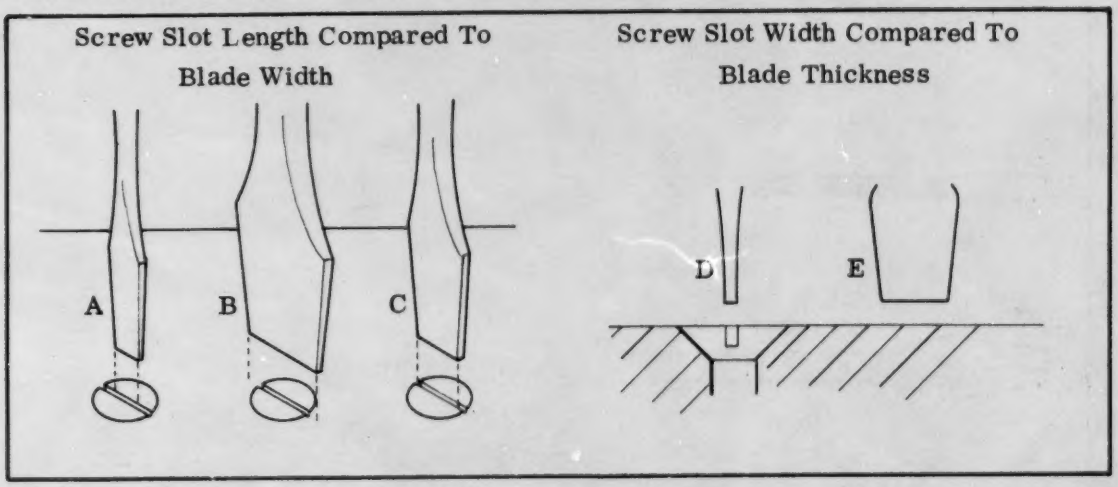


These screwdrivers have flattened wedge shaped ends which fit into the straight slot of a screw head. The conventional and heavy duty screwdrivers vary in length from approximately 3" to 12" with the shank diameter and the width and tip thickness proportional to the length. To measure a screwdriver length start at the blade tip and move up to the bottom of the handle.

For the usual screwdriver task the conventional shank screwdriver is used. The heavy duty screwdriver is equipped with a square shank. A wrench can be fitted to this shank to help drive or remove large or stubborn screws. Electrician's screwdrivers have long thin shanks with the blade width being approximately the same width as the shank diameter. Handles for electrician's screwdrivers are insulated. But again, this is secondary safety, not primary safety, or the only safety precaution to be taken. This is a useful tool for handling small screws.

The offset screwdriver has two blades, one at either end of the tool. These blades are at a 90° angle to each other. It is designed for use in spaces where there is a lack of room for the conventional screwdriver. The stubby screwdriver (close quarter screwdriver) is a tool which has been designed for use in areas where there is limited work room.

SELECT STANDARD SCREWDRIVER FOR THE JOB



The correct blade must be selected for the screw to be driven or removed. As indicated in illustration A the blade tip is too narrow for the screw. Being too narrow, it is more than likely also too thin for the slot. The blade being too narrow tends to damage the screw head. If the blade tip is too thin, it will tend to twist and distort, making the screwdriver useless. Damaged screw heads are dangerous, as well as being difficult to drive or remove. Illustration B indicates the screwdriver as being too wide. This will have the tendency of damaging the work. Illustration C indicates the correct fit. Blade width is correct for screw slot length; also blade thickness is correct for screw slot width.

Illustrations D and E indicate a correctly ground blade. Illustration D shows that the sides of the blade are ground slightly concave. This helps to hold the tip more firmly in the screw slot as pressure is applied to the screwdriver.

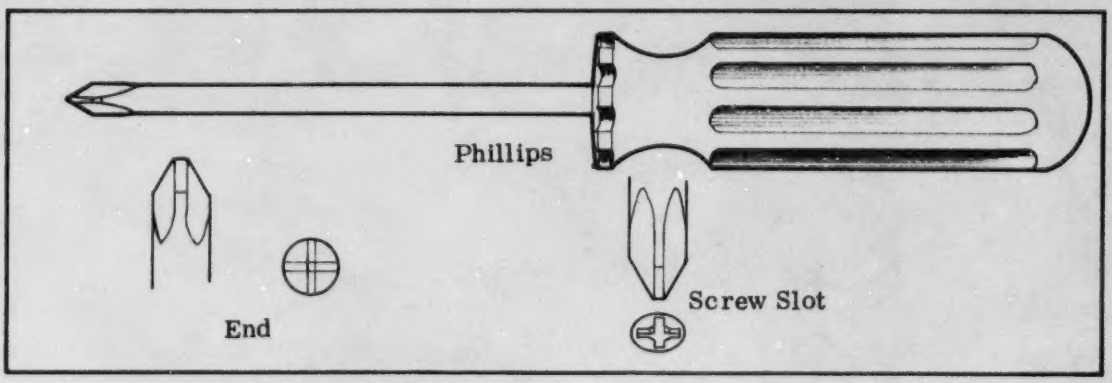
To drive or remove a screw, the screwdriver is held square with the screw and slot. The opposite hand is used to guide the blade into the slot and maintain proper alignment.

Worn blade tips must be reground. The grinding is done with a fine grinding wheel and very little pressure. Avoid overheating the tip. As the tip is ground, stop and check it for correct fit in a screw slot. Maintain the original taper and concavity. Blades are not to be ground to a knife edge or at too steep an angle. This will cause the blade to twist or climb out of the screw slot.

Safety

1. Goggles, safety glasses, or face shield must be worn when reshaping screwdriver blade.
2. Screws with burred heads are dangerous. Burrs will cut and scrape the skin. Screwdrivers slip causing other injuries. If the screwhead is not too badly damaged, it can be repaired by filing or sanding. Better, be safe and replace the screw.
3. When working with electricity, use only insulated screwdrivers. Shut off current. When it is impossible to shut off the current, use a full length insulated screwdriver and keep hands free of any wires. When working away from an open switch, tag it. This is to keep someone from turning it on.
4. If it is necessary to hold a small unit in a hand, no downward pressure is applied to a screwdriver. The screwdriver can slip, which will cause the tool to pierce the hand.

PHILLIPS SCREWDRIVER



Dimensioning of phillips screwdrivers is the same as the conventional screwdriver. Length: tip - to handle. Tip proportionate to shaft diameter. Use and maintenance are the same. The main difference is the X shaped tip.

CAUTION:

Screwdrivers are not substitutes for other tools.

1. They are not Chisels, Punch, or Drift. Hammering on a handle can split it, rendering the tool useless. Tips can be damaged beyond repair.

EXCEPTION: Screwdrivers with the steel shank extending through the handle may be tapped on with a hammer.

If a screw slot is corroded or is full of rust, it is appropriate to gently tap on the handle while holding the screwdriver at an angle to clean the slot. After the screw head slot is clear, it is permissible to gently tap the screwdriver seating the tip firmly in the slot.

2. They are not pry bars. Tips are hardened to prevent rapid wear. The harder a tip the easier it will break. When a tip snaps, personal injury can accompany the ruining of a tool. The shank of a screwdriver will more than likely bend when the tool is used as a pry bar. Once the shank is bent it is very difficult to straighten and realign. A bent shank makes it very difficult to keep the screwdriver centered in the screw.

3. Pliers are not to be used on a round shank screwdriver. If heavy work is to be done, select the correct size heavy duty screwdriver with the square shank and use a wrench.

4. Screwdrivers are not to be used to check an electrical circuit. Arcing will melt the screwdriver blade; also heat will draw the temper from the metal.

SIMPLE RECALL TEST
ON
SCREWDRIVERS

Directions; Read each statement carefully. Select a word or words which will complete the statement correctly. Place your answer in the blank space to the right of each statement.

1. The two most used screwdrivers are the standard blade and the ____ head. _____

2. Screwdriver tips are heat treated to withstand wear and ____. _____

3. When there is insufficient space to use a conventional shank screwdriver a ____ screwdriver is used. _____

4. The screwdriver which has been designed for use in areas where there is limited work room is a ____ screwdriver. _____

5. If a screwdriver blade tip is too narrow for a screw slot one of two things may happen; either the screw slot will be damaged or the screwdriver tip will ____. _____

6. A correctly ground common screwdriver blade has the sides slightly ____. _____

7. A correctly ground common screwdriver blade helps to hold the tip more firmly in the screw slot as ____ is applied to the screwdriver. _____

8. One hand holds the screwdriver while the other hand guides and ____ the blade with the screw. _____

9. As the blade of a screwdriver is reground correct fit is checked by fitting it in a ____. _____

10. A screwdriver blade that has been ground at too steep an angle will tend to twist or ____ of the slot. _____

11. When working with screws and connections near live wires, use an ____ insulated screwdriver, and keep hands free of any wires. _____

12. If it becomes necessary to hold a small unit in a hand to tighten screws, no ____ pressure is applied to the screwdriver. _____

13. The screwdriver with an X-shaped tip is a ____ screwdriver. _____

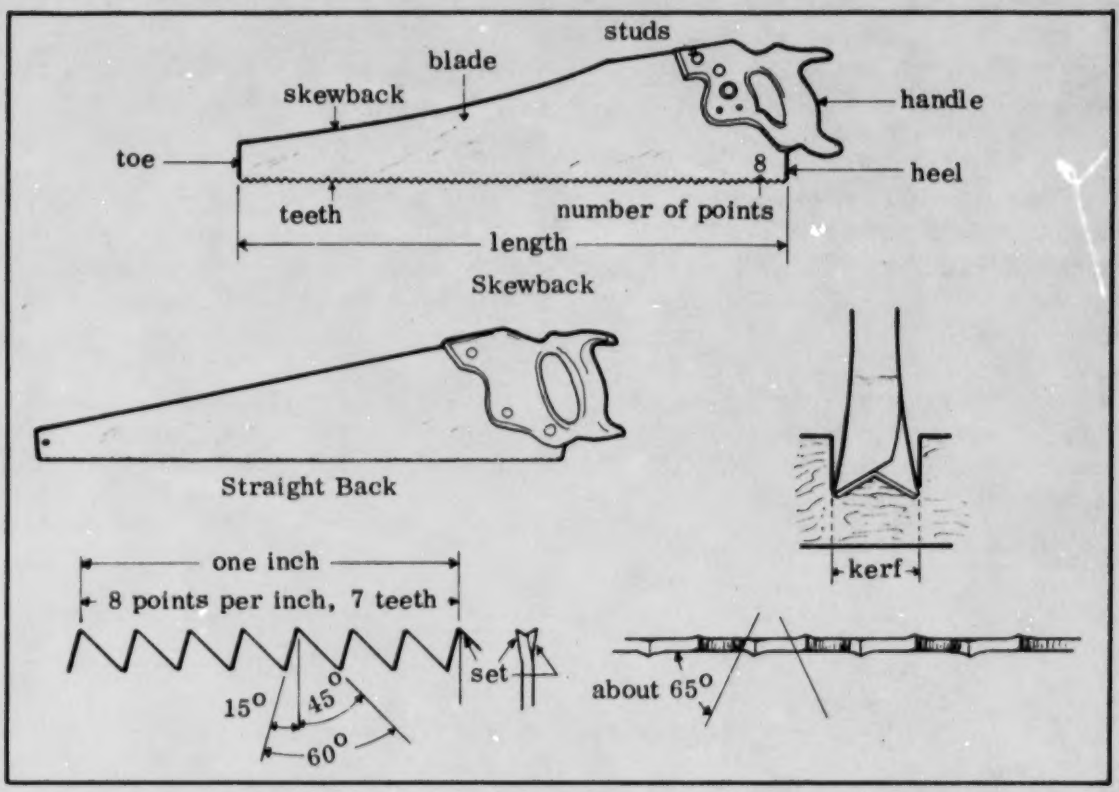
14. Hammering on a screwdriver handle, plastic or wood, will cause damage by possibly ____ it. _____

15. A screwdriver is not a pry bar because it does damage to the tip and ____. _____

SAWS

A part of the electrician's tool kit is saws. Those most commonly used are the Crosscut Handsaw, Keyhole, Hacksaw, and Power Saw.

CROSSCUT HANDSAW



A good crosscut saw with a tooth range of from 8 to 11 points should be included in every electrician's tool box. Saw teeth size depend on the number of points per inch. There is one more point than teeth. The number of points is very often stamped on the blade face at the heel, such as the illustration of the skewback handsaw.

As is indicated by the name, crosscut handsaw means the saw is designed to cut across wood grain. The saw teeth are pointed and set at an angle, every other tooth to the opposite side.

The teeth cut a kerf in the wood wider than the saw blade is thick; therefore, the blade will run freely while cutting the wood with no binding.

Saw blades are manufactured in different shapes and lengths. The lengths for a crosscut saw vary from 20" to 28". The popular lengths are 24" to 26".

The first saw illustrated is the skewback. There is a slight curve in the back down toward the toe. This curve gives the toe of the blade greater flexibility, and a slight curve can be cut with this part of the blade. Too, the top point of the toe can be easily found and used for sighting when a cut is started.

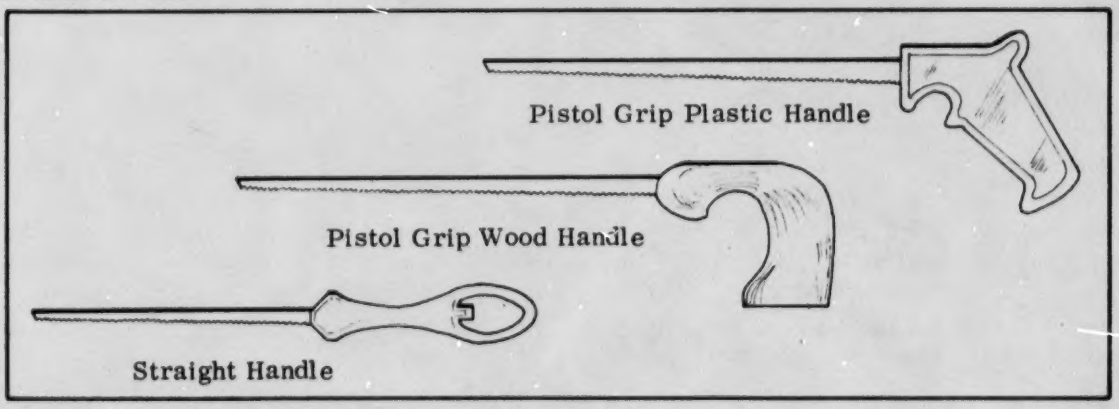
The second saw has a straight back. It is not flexible like the skewback, but it does have the advantage of being used as a straight edge for laying out lines.

Saw blades are made of spring steel. The temper in the spring steel allows the teeth to be filed and set, and as the saw is used the blade keeps its shape and the teeth maintain their cutting edge.

The saw blade face is ground and polished and may be slightly lubricated; however, all lubricants must be kept out of the teeth because it helps to clog them. The teeth edge of a blade is usually slightly thicker than the other portion of the blade. This strengthens the teeth edge, allows for less teeth set, and gives clearance for the back edge.

Saw handles are made of fine-grain hardwood and shaped to comfortably fit the hand. Handles are also moisture proofed with a durable long lasting finish. Brass studs are used to fasten handles to blades. Handles must be kept tight on blades, and this is done with the brass studs.

KEYHOLE SAW



Keyhole saws have blades about eight to ten inches in length with teeth filed in such a manner that the saw is used for ripping or crosscut. These saws are used for cutting sharp curves and openings of various shapes as may be needed for lighting fixtures and other electrical equipment.

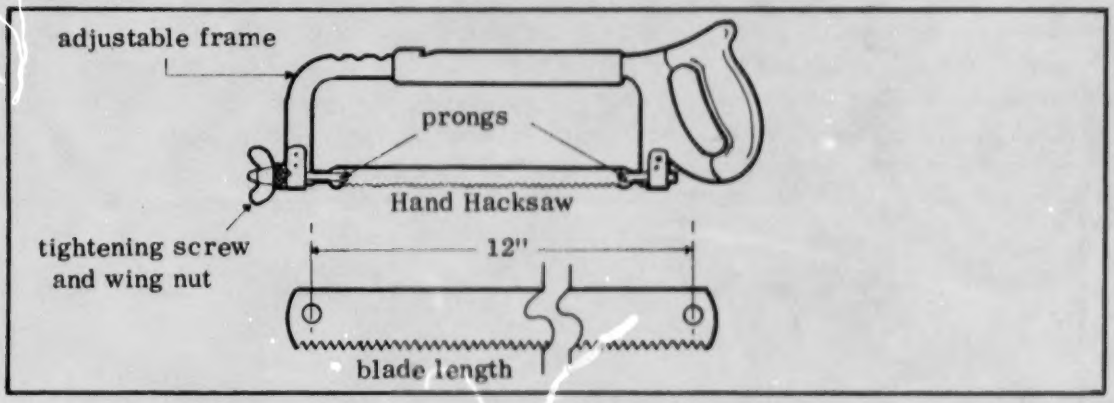
Caution must be exercised when cutting not to bend or buckle the blade by applying too much pressure. Remember that the farther out on the end of the blade being used to saw, a lesser amount of pressure is to be used. There are times when a hole must be bored before the saw can be used to further shape the opening.

The hacksaw is used to cut heavy cable, pipe, and conduit. On occasion it becomes necessary to cut other metals; some may be heavy metal.

Hand hacksaw frames are available in different lengths or adjustable so that different length blades can be used. Hand hacksaw blades are available in 8", 10", and 12" lengths; however, the 10" and 12" blades are more often used. The length of a blade is determined by the distance between the centers of the blade attaching holes at each end.

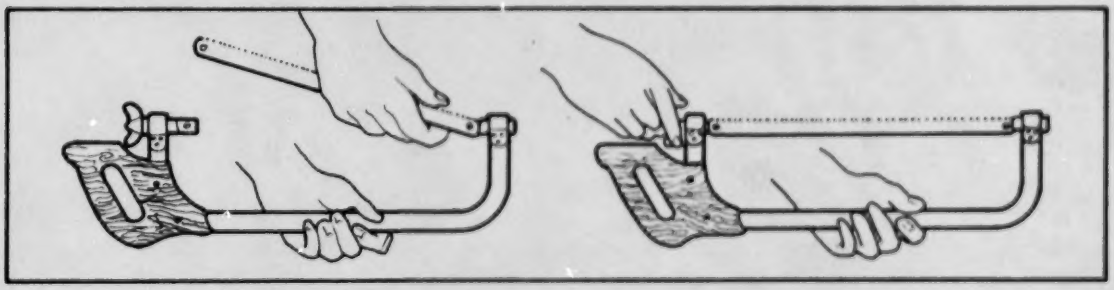
A hand hacksaw is made up of a handle, a frame, prongs, a tightening screw, a wing nut, and a blade. For the electrician it is more practical to purchase the adjustable type frame for universal use.

HACKSAW



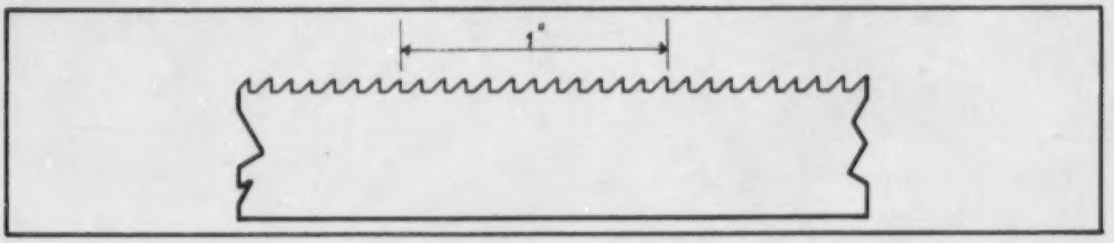
To install a blade in a frame first turn the frame so that the opening for the blade is up. Position the blade with the teeth up and pointing away from the handle.

Hook the blade onto one prong and then onto the second. Tighten the blade firmly with the adjusting screw and wing nut. The blade should have no slack because a loose blade is apt to break, kink, and it will make a crooked cut.

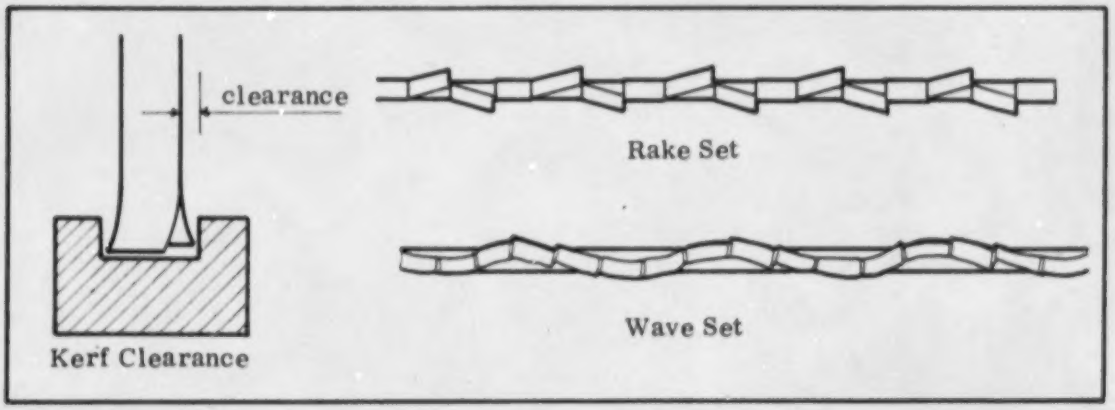


The two types of hacksaw blades are made of tool steel. The blades are hardened and tempered. One type blade is the all-hard blade which is hardened throughout. The second type blade is the flexible which has only the teeth hardened.

Hacksaw blades are selected for a job by the number of teeth per inch and all-hard or flexible. For heavy cross section metals select an all-hard blade. For light pipe, tubing, and light cross section metal select a flexible blade. All blades have approximately the same dimensions for thickness .025" and for width 1/2".



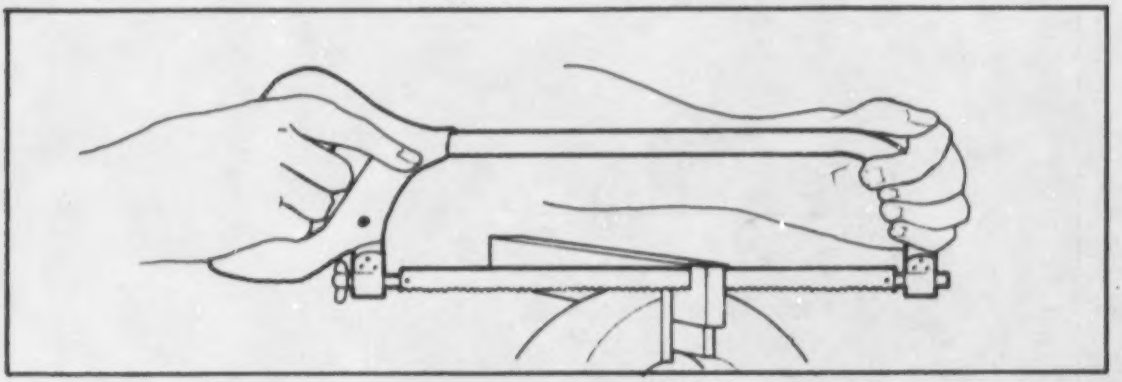
In order to cut a job in two, the teeth of a saw must cut a wider kerf (slot) than the blade is thick in order to keep the blade from binding and hanging up. In order to saw a wider kerf than the blade is thick, the blade teeth are set. Saw teeth set means that the teeth are bent right and left. Saw teeth are set either rake (alternate-set) or wave. Rake set has one tooth bent right, the next tooth bent left, and a straight tooth; then the procedure starts over. Wave set (wavy) alternately has several teeth bent left and then several teeth bent right.



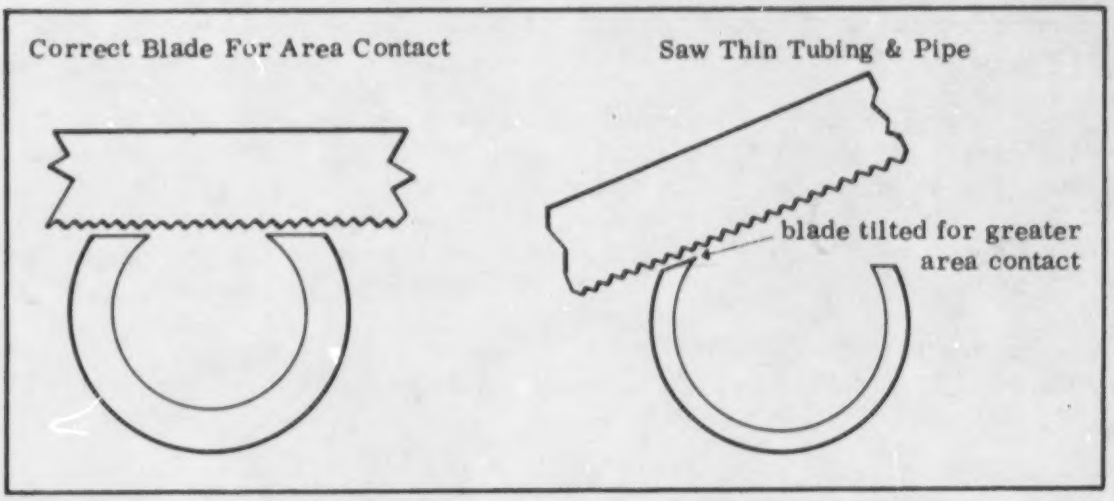
14 and 18 teeth per inch are rake set, whereas 24 and 32 teeth per inch are wave set. 14 teeth per inch blade is used for sawing large sections of mild metals. 18 teeth per inch blades are used to saw large sections of tough metals. 24 teeth per inch blades are used to saw heavy pipe, brass, copper, flat stock iron, and angle iron. 32 teeth per inch blades are used for thin wall pipes, thin wall tubing, and the like.

To make a cut with a hacksaw first notch the place where the cut will start with a file. Hold the hacksaw handle with one hand and grasp the front end of the saw frame with the other hand. Stand with the body at about a 30-degree angle to the work. Place the second foot 8" to 12" from the other foot and slightly behind it. Place the saw blade on the work piece at the file notch. Make the first saw stroke by pulling the saw back across the work piece. As the saw will cut only on the forward stroke, press down with this stroke. Raise the saw slightly on the back stroke. Use the full

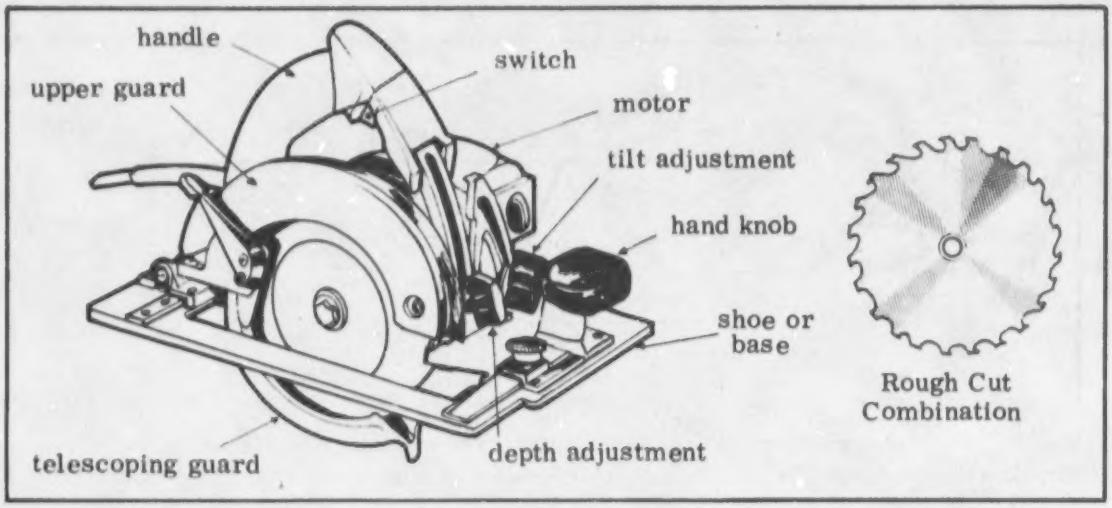
length of the saw blade on both strokes. The saw blade will warm up after a few strokes and some slack will occur. Tighten the tension on the blade at this time.



Be sure to use the correct hacksaw blade for the job. A simple rule of thumb to follow when selecting a blade is that at least two saw teeth should be contacting the area of the work piece being cut.



POWER SAWS



When power is available the electric power saw reduces the time needed to perform many tasks in the electrical trades. The saw is light in weight, easy to use, and easy to handle and carry.

The first thing a person must do before operating the power saw is to become well acquainted with it. First, the way in which it operates: off and on, safety features, etc. Second, the procedures laid out for its use.

Next the operator must be wide awake and alert at all times: (1) not overly tired, (2) not ill, (3) not having worked an extended number of hours, (4) not trying to rush.

Maintain concentrated attention on work. Never distract someone else who is using the saw. To talk, listen, or size up job; shut off the power, allow the blade to stop and then conduct necessary side business.

Before performing a job with the power saw: (1) mentally think through the job, (2) plan the job thoroughly, (3) lay the job out, and (4) check the tool for proper operation, adjustments, sharp blade, etc.

Electric power is an item that must be respected. Inspect power cords for proper ground and good condition. Make sure power source is of the proper voltage for the saw. Check saw switch for OFF position before plugging the power cord into the power outlet.

The saw is fed into the workpiece very carefully and at a speed no faster than the saw will cut it easily. An overload can be hazardous. The operator may be injured, the saw can be damaged, or perhaps both.

The most popular size saws are 7" or 8". The size of a saw is determined by the

largest diameter saw blade that it will take. Blade cutting depth is adjusted by raising or lowering the shoe or base. Some saws have a tilting shoe or base which makes it possible to cut a level. The saw is especially adaptable to making cuts in assembled work; studs, flooring, roofing, etc.

Saw blades are of four usual types. Rough Cut Combination - This is the most popular because it is a free-cutting general purpose blade for cutting in any direction: ripping, crosscutting, mitering on both hard wood and soft wood. Rip - sawing with the grain. Crosscut - cutting across the grain. Master Combination (Standard Combination or Miter) - This is an all purpose blade giving a smooth fast cut. Cuts crosscut, rips, miters for general use. There are other specialty saws for paneling, flooring, etc. Some blades have carbide tips which cause the blades to have a longer life and stay sharper longer. Saw blades teeth set is about 2½ gauges to each side of the blade. This gives more clearance in the saw kerf and allows the saw to be guided "free-hand" along a layout line.

To operate a power saw:

1. Grasp the handle with a firm grip of one hand.
2. Index finger of that hand is positioned to operate the trigger switch.
3. Position the shoe or base on the work.
4. Align the blade guide mark with the layout line.
5. Rest the other hand on the work but out of danger of being cut by the saw.
6. Pull the trigger switch and permit the saw to reach maximum speed.
7. Feed the saw evenly and smoothly into the work.
8. Release the trigger switch when the cut is completed; allow the blade to come to a stop.
9. Now the saw may be set aside, stored, or whatsoever.

Safety

1. Material to be cut is positioned and supported in such a manner as not to allow the kerf to close and bind the saw blade during or at the end of a cut.
2. This material must be supported very near the point of cut.
3. Small or short workpieces are to be clamped to a bench or sawhorse.
4. Take care not to cut into nails, sawhorse, or supporting base.
5. Depth of cut must be adjusted to the thickness of the material plus approximately 1/8".
6. Check all adjustments for tight and that blade is firmly attached to arbor.
7. Position power cord in such a manner that it will not become tangled in the saw and work.

8. Place saw shoe or base on the work, making sure the blade is clear before turning on the saw switch.
9. Stand to one side of the kerf as the cut is being made.
10. Keep hands from under the material being cut.
11. The power cord must be removed from the power outlet before a saw is adjusted or a blade is changed.
12. Select and use a blade that is sharp and properly set.
13. Wear goggles.

REGULAR TRUE-FALSE TEST
ON
SAWS

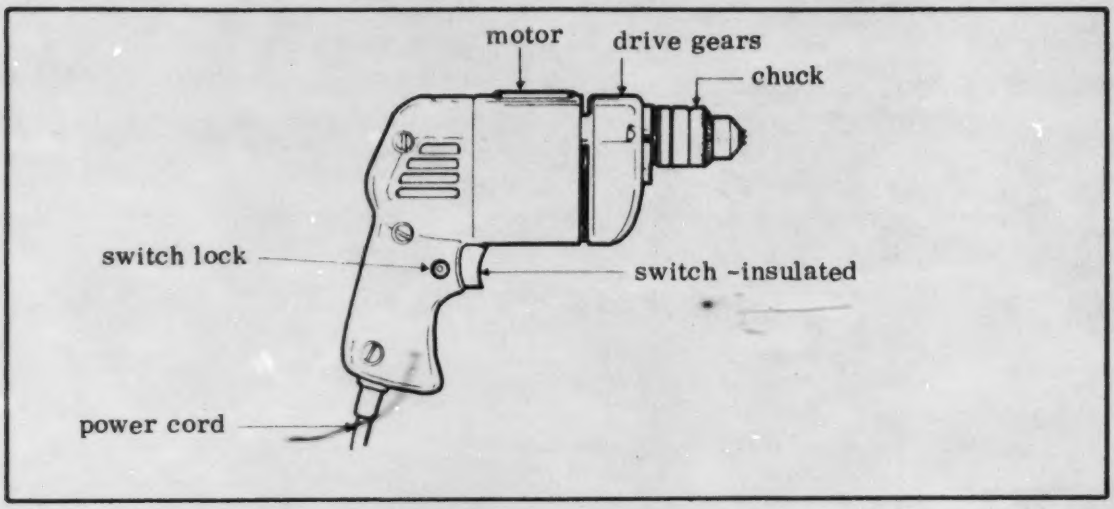
Directions: Read each of the following statements carefully before making a mark. Some of the statements are true and some are false. Indicate the answer selected by placing a small circle around the T or F in the corresponding right-hand column.

1.	Handsaws most commonly found in the electrician's tool box are the ripsaw, keyhole saw, hacksaw, and power saw.	T	F
2.	Handsaw teeth size depend on the number of points per inch.	T	F
3.	The number stamped on the heel of the saw is the number of teeth per inch.	T	F
4.	The teeth side of handsaw blades are usually thicker than the opposite side of the blade.	T	F
5.	Teeth are set on a handsaw to give the cutting side more rigidity and strength.	T	F
6.	The skewback handsaw has a curve in the back down toward the toe; this gives the toe of the blade more flexibility.	T	F
7.	A keyhole saw has ripsaw teeth.	T	F
8.	When the end of a keyhole saw is being used to saw with, more pressure on the saw is needed because of the teeth size and distance from the handle.	T	F
9.	Hacksaw blades come in lengths of 8", 10", and 12".	T	F
10.	Hacksaw blade length is measured from tip of blade to tip of blade.	T	F
11.	Hacksaw blade teeth are pointed toward the handle because cutting is done on the back stroke.	T	F
12.	Hacksaw blades of 24 to 32 teeth per inch are wave set.	T	F
13.	A rule to follow when selecting a hacksaw blade is that at least two teeth should contact the area of the workpiece being cut.	T	F
14.	The size of a portable power saw is determined by the depth that it will cut.	T	F
15.	Ease of free-hand sawing with a portable power saw is accomplished by saw teeth set to either side of the blade.	T	F
16.	The portable power saw base is placed on the workpiece with the teeth clear of the work before the power is turned on.	T	F

DRILLING TOOLS AND EQUIPMENT

Either power driven or manual drilling equipment and tools are needed to make holes in both new construction and reworked structures for the installation or reworking of conduit and wire.

ELECTRIC POWER DRILL



Electric portable drills come in different sizes and a variety of types. The size of an electric portable drill is determined by chuck size. The chuck is that part of the drill that holds the drill bit. The three most used electric portable drills are 1/4", 3/8", and 1/2"; however, there are other sizes.

Later model drill motors have variable speeds and are reversible. As in the illustration, probably the most popular type drill is the pistol grip type. This is because of its versatility and flexibility.

To use the electric portable drill:

1. Select the proper size bit, twist drill, hole saw, etc.
2. Inspect drilling or cutting accessory for good condition and sharp.
3. Install accessory in chuck and tighten chuck firmly with chuck key.
4. Position point of accessory on center point of hole to be made.
5. Hold drill at correct angle; start electric drill motor.
6. Apply pressure evenly and smoothly, feeding the hole cutting device into the workpiece.

   CAUTION: Bit, twist drill, or hole saw is not to be wobbled as the hole is being made.

7. Back the bit, etc. out as needed to clear away shavings or waste.

8. Ease up on pressure as you feel the tool through the workpiece.

9. Back the tool out of the finished hole.

10. Shut off motor.

DRILL AND DRILLING SAFETY

1. Check electrical connections and power cord for good condition.

2. Loose stock must be held firmly in position before drilling.

3. Electric power drill is to be connected to a properly grounded power outlet with switch in off position.

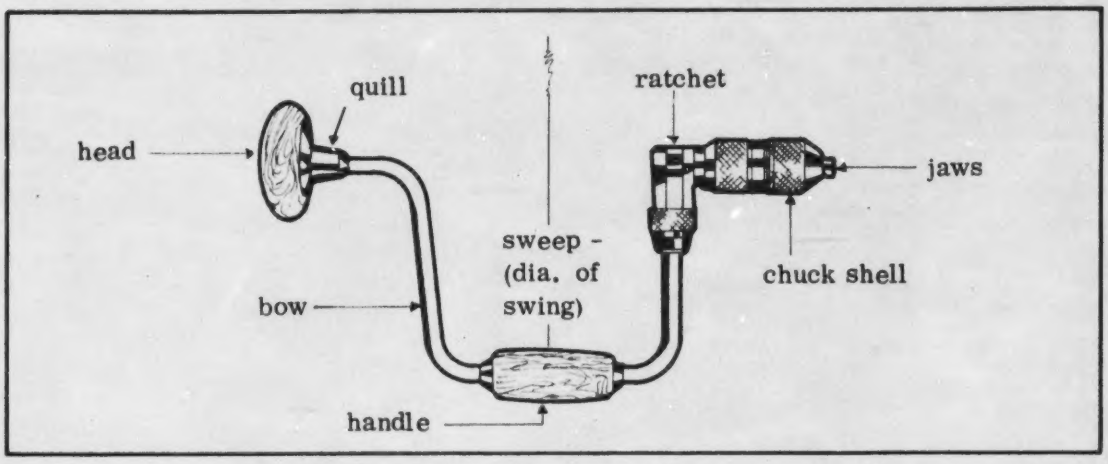
4. Remove bit or other tool from drill chuck as soon as work is completed.

5. Loose clothing is not to be used when using an electric power drill.

6. Long hair must be tied back or covered.

7. Wear goggles.

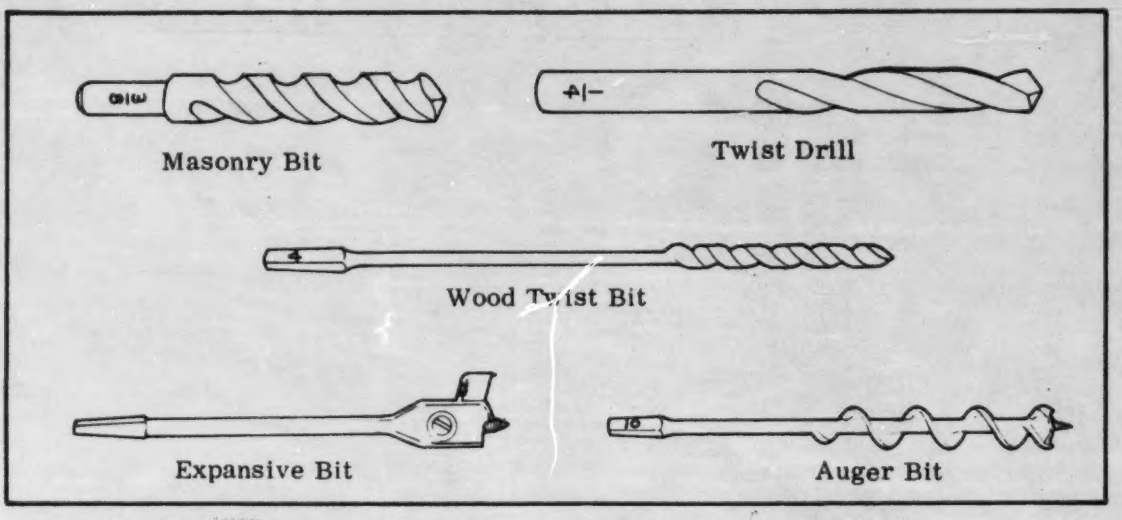
BRACE



The brace is a tool designed to hold various types of square shank bits. The brace illustrated here is of the ratchet type. The sweep or diameter of the swing of the brace handle is the diameter of the circle which the handle makes when revolved. The ratchet allows for the altering of the swing, permitting holes to be bored near walls, corners, or ceilings where a complete turn of the handle cannot be made.

A bit is inserted into the chuck jaws and the jaws are tightened by grasping the chuck shell with one hand and twisting to the right.

DRILLING EQUIPMENT



The auger bit is used to drill holes in wood or other soft materials, but not metal. The common range of sizes is from $\frac{1}{4}$" to 1". There are other sizes available. The size is stamped on the shank or tang. This is often a whole number which indicates the number of sixteenths.

The tip of the bit is a screw. This screw centers and pulls the bit into the material. The electrician usually uses a coarse screw. The coarse-screw bit is usually used by an electrician for rapid cutting.

On either side of the screw are spurs or nibs which score the outer edge of the chip which is removed by the cutting edge or lip. From there the chips feed into the throat and out the twist. These bits may have a solid center, as illustrated, single twist, or double twist.

Expansion bits are used for boring holes in excess of 1". Cutter blades of different lengths are available. The blades are calibrated and adjusted in or out as needed. They are available to bore holes up to 4".

Wood twist bits have points ground to an included angle of 60^{o} for entering wood easily. They range in size from 1/8" to 1/2" in increments of thirty-seconds of an inch. The number of thirty-seconds is stamped on the tang.

High speed twist drills are used with the electric power drill. They are for drilling metal.

The masonry drill has a $\frac{1}{4}$" round shank. The drill size is indicated on the drill bit shank. There are numerous sizes but the usual are 3/16", 1/4", 5/16", 3/8", and 1/2". There are those drill bits that have carbide tips. The masonry drill makes it possible for the electrician to install anchor bolts and the like in hard surfaces.

SIMPLE RECALL TEST
ON
DRILLING TOOLS AND EQUIPMENT

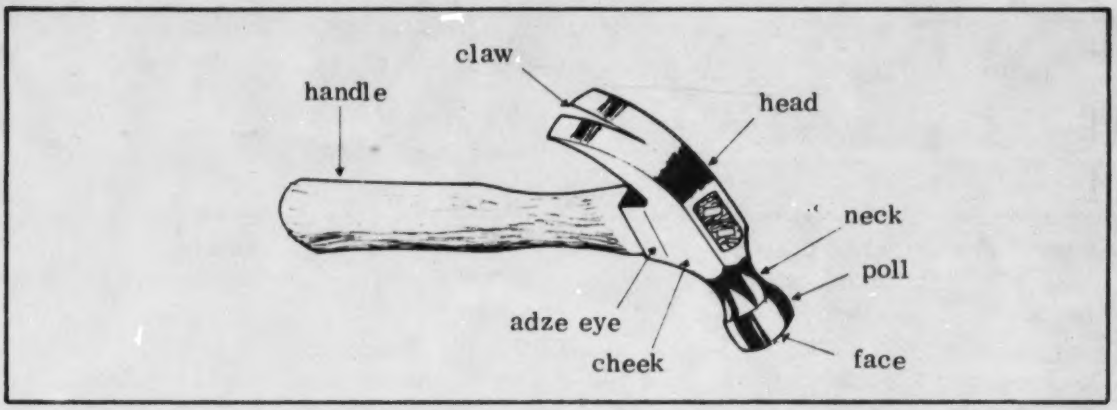
Directions: Read each statement carefully. Select a word or words which will complete the statement correctly. Place your answer in the blank space to the right of each statement.

1. Holes in structures are drilled or cut by the electrician for the installation of ____ and wire. _____
2. The size of an electric portable drill is determined by the ____ size. _____
3. Because of its versatility and flexibility, the most popular type portable electric drill is the ____ type. _____
4. To drill a hole, position the point of the drill on the ____ of hole to be drilled. _____
5. An electric power drill is to be connected to a properly ____ power outlet with switch in "off" position. _____
6. The brace is a tool designed to hold various types of ____ shank bits. _____
7. The ratchet type brace allows for the altering of the ____, permitting holes to be bored near walls, corners, or ceilings. _____
8. The tip of an auger bit is a screw which centers and ____ the bit causing the wood or soft material to be drilled or bored. _____
9. The electrician usually uses an auger bit with ____ threads. _____
10. On either side of the auger bit screw are ____ which score the chip. _____
11. Expansion bits are used to bore holes in excess of ____. _____
12. Wood twist bits have a point which is ground to an included angle of ____ degrees. _____
13. The wood twist bit point is ground to the angle of degrees for entering ____ easily. _____
14. High speed twist drills are used for drilling ____. _____
15. The masonry drill bit makes it possible for an electrician to install anchor bolts and the like in ____ surfaces. _____

HAMMERS

Hammers are a part of the electrician's tool kit for nailing, fitting, and use with chisels. There are few trades that do not use a hammer at all. But for the most part, it is a necessary tool that can and does fill a necessary requirement.

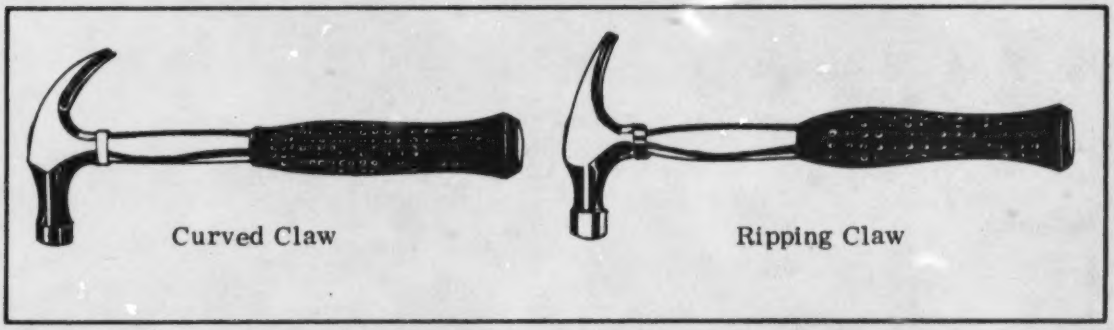
CLAW HAMMER



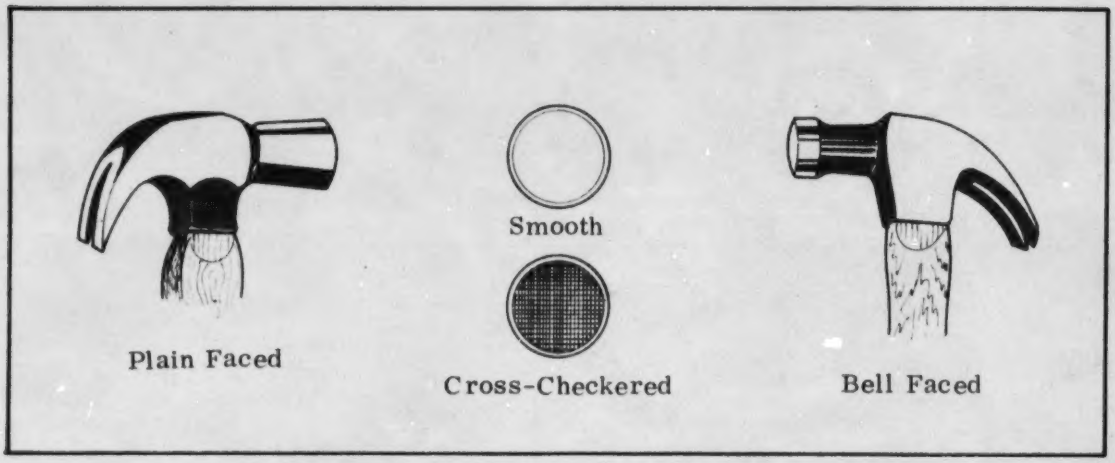
This is a common tool for the driving of fasteners, removal of fasteners, driving nail sets, used with wood chisels, etc. There are techniques of holding, using, and maintaining this tool that should be learned before taking on a task which requires its use.

A good hammer is made of quality alloy drop forged steel. When these heads are tempered and treated properly, they are much stronger than ordinary steel.

The claw hammer is sized by the weight of its head. Common sizes are 7 oz., 16 oz., and 20 oz. The 16 oz. hammer is the general purpose tool, whereas the 20 oz. is the heavy duty tool. Therefore, hammers are selected according to the weight best suited to the task.



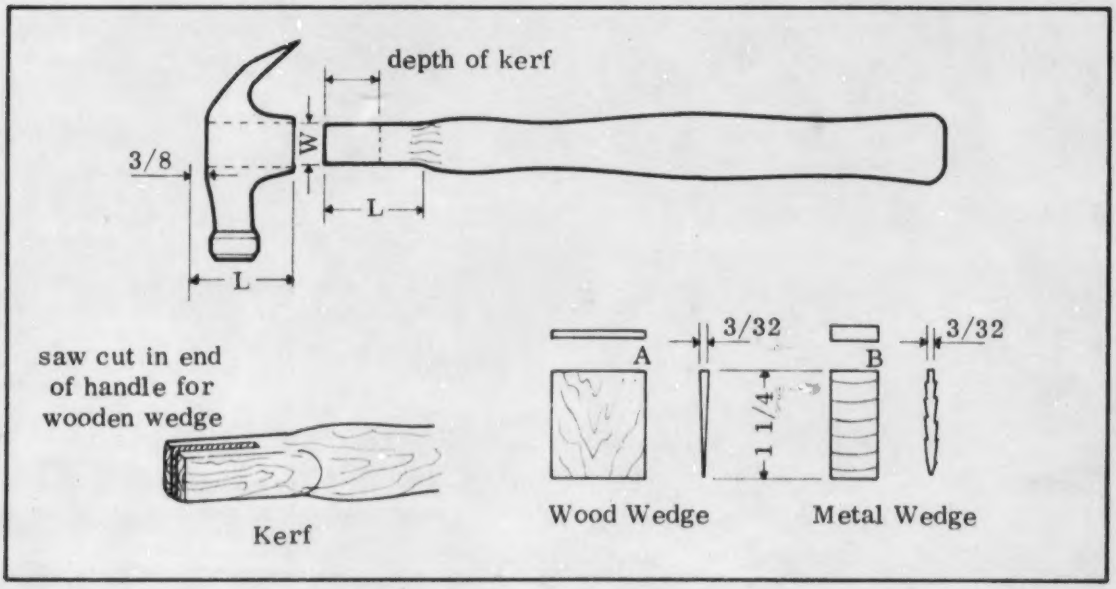
There are two types of claw hammer heads, the curved claw which is more adaptable to the removal of nails and fasteners and the straight claw or ripping claw hammer which is adaptable to prying wood construction apart.



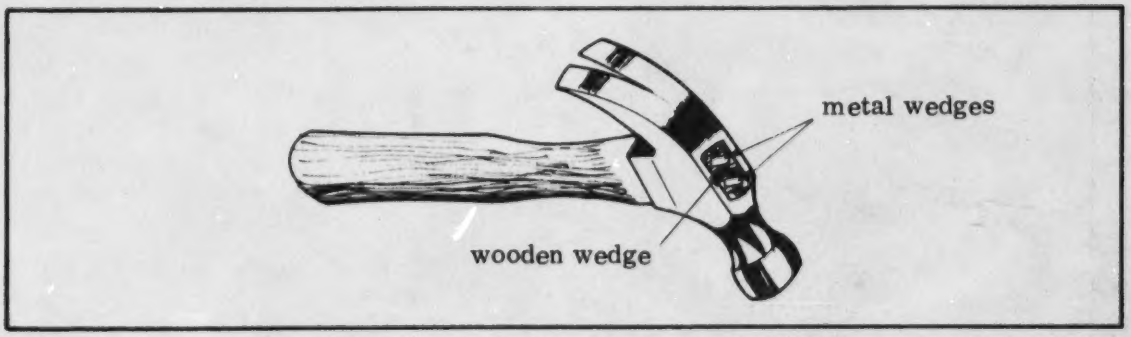
Claw hammers have different type faces. The plain faced is more or less flat and used for rough work because it has a tendency to leave face marks when driving fasteners. A bell face is slightly convex in shape; therefore, it is more difficult to use because of the tendency to slip off a fastener or bend it. More practice and skill is needed to use this hammer. Advantages of the bell face is that it has less tendency to leave face marks in the work. Fasteners can be driven flush or even slightly below surface level with little or no marks left.

Also, hammer faces may be smooth or checkered. Checkered faces naturally have less tendency to slip off the surface being hammered, but they do leave the checkered marking on hammered surfaces.

WOOD HAMMER HANDLE REPLACEMENT



1. Remove old handle. Saw off near eye.
2. Remove remainder of handle from eye. Drive out front side of eye, use chisel or punch.
3. Shape new handle to fit back side of eye. Hold handle in wood vise; use spoke shaver and wood file.
4. Shape end of handle and align with remainder of handle. Shape to taper allowing handle to protrude 3/8" beyond front of eye.
5. Make saw kerf in tapered end of handle. To receive wood wedge, use handsaw for larger handles, backsaw for smaller handles. Saw kerf depth to 3/4 width of hammer eye.
6. Drive handle into eye. Handle to extend 3/8" beyond eye. Hold handle upright, hammer head at top end. Grasp handle near center and bring butt end down sharply on a solid piece of wood until driving is completed.
7. Prepare wood wedge. Approximately 3/32" thick, same width as hammer eye height, and approximately 1 $\frac{1}{4}$" long.
8. Drive wood wedge in kerf of hammer handle to maximum tightness.
9. Saw off $\frac{1}{4}$" of handle protruding through hammer eye.
10. Make starting grooves for metal wedges in 1/8" portion of handle protruding from hammer eye. Two grooves at slight diagonal across end of handle. Use hammer and cold chisel.

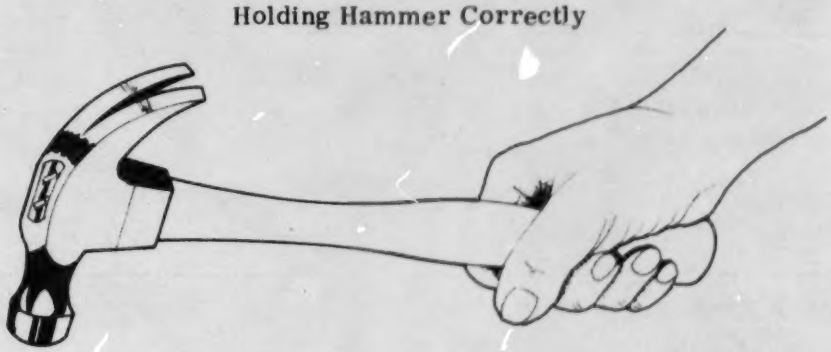


11. Drive metal wedges. Use flat of ball peen hammer. Drive to maximum depth.
12. Cut off remaining 1/8" inch of handle protruding through hammer eye. Use hacksaw.
13. Finish handle end and wedges. Use coarse double-cut file. Hammer head is not to be scored with file.

USE THE HAMMER

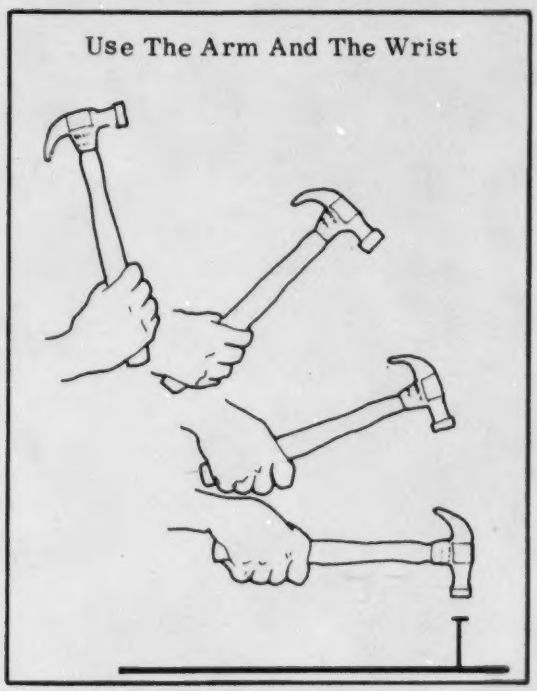
Rub the face of a hammer with a piece of sandpaper to clean grease and dirt off the face. Grease or dirt can cause the hammer to slide or slip off the object being driven.

Holding Hammer Correctly



Grasp the handle firmly with one hand near the end of the handle. This gives more leverage for driving power and one reason for practice in using a hammer.

Use The Arm And The Wrist

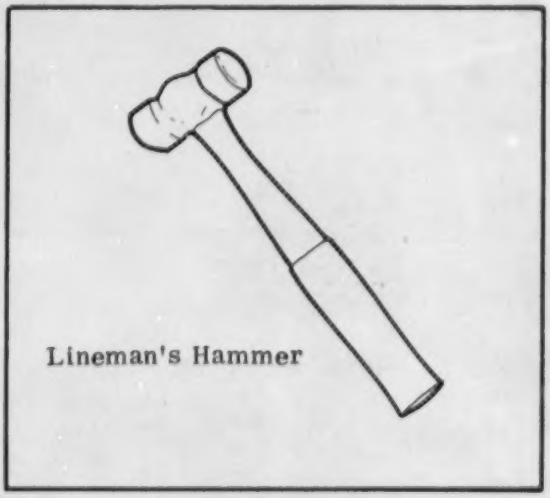


Driving is done with well directed blows of the hammer. In driving with the hammer it is desired that the object, nail, etc., be hit squarely and as near in the center of the hammer face as possible.

Hammer blows are made with the muscular action of the wrist, elbow, and shoulder. Depending upon the force of the blow, one or all of these actions may be used. Light hammering is done with the wrist and some little elbow motion. As the intensity of the hammering increases wrist action is used with increased elbow action. Heavy hammering requires wrist action, elbow action, and shoulder action.

Lineman's Hammer:

This hammer is designed for pole-line work. It has weight for driving in lag bolts, hooks, and the like. The hammer is made of tempered steel. The head is 3 3/4" long with twin faces round crowned and 1 3/4" in diameter. The hammer weight is 36 oz. with an overall length of 14". This hammer lends itself to being used in confined places.



Lineman's Hammer

REGULAR TRUE-FALSE TEST
ON
HAMMERS

Directions: Read each of the following statements carefully before making a mark. Some of the statements are true and some are false. Indicate the answer selected by placing a small circle around the T or F in the corresponding right-hand column.

1.	Claw hammers are sized by the weight of the head.	T	F
2.	A 20 oz. claw hammer is considered the general purpose type and used as such.	T	F
3.	The straight claw hammer is adapted for pulling nails and other fasteners.	T	F
4.	The bell face claw hammer is more difficult to use, but it is less apt to leave hammer marks on the workpiece.	T	F
5.	A plain face claw hammer is used for rough work.	T	F
6.	New wooden hammer handles are driven to the eye of the head with the flat of a ball peen hammer.	T	F
7.	Wooden wedges are driven into kerf of a new wooden hammer handle 1¼ inches.	T	F
8.	To use a hammer, the handle is grasped near the end.	T	F
9.	Hammer blows are made with the muscular action of the wrist, elbow, and shoulder.	T	F
10.	A lineman's hammer is designed so that it can be used in confined places.	T	F

SOLDERING EQUIPMENT AND SUPPLIES

For electrical work, splices, taps, etc., solder is used unless solderless connectors are installed. A good solder joint is stronger both mechanically and electrically.

SUPPLIES

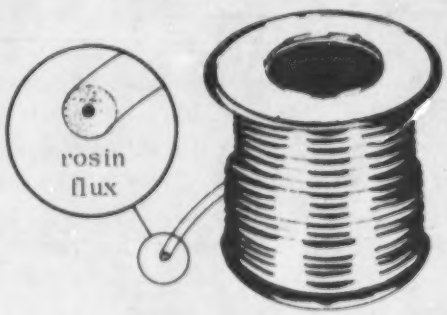
Solid Core Solder

Soldering Paste

Solder for electrical work is an alloy of tin and lead. The most popular is 60% tin and 40% lead. The lead content determines the melting point and the tin lends strength.

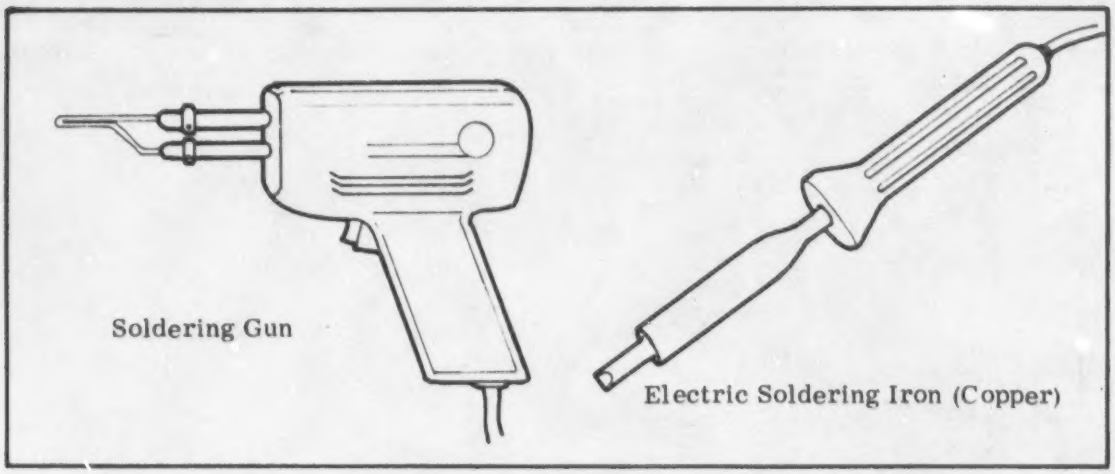
Solid core solder requires a flux (soldering paste). This removes oxidation and other foreign material from splice or tap. The flux is a noncorrosive material.

On small jobs rosin core solder is preferred because the flux is in the center of the solder and cleaning action takes place as the task is performed.



Rosin Core Solder

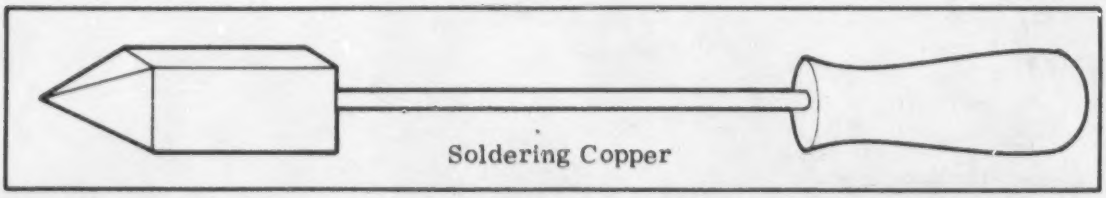
ELECTRIC POWER SOLDERING EQUIPMENT



The soldering gun is very adaptable to electrical tasks. It is light and very flexible in use. Different shapes of tips are available and may be replaced as needed. It gets hot rapidly, which speeds up the task.

The electric soldering iron has two type tips: wedge and square. It will hold a uniform heat. The electric soldering iron is available in a wide range of sizes.

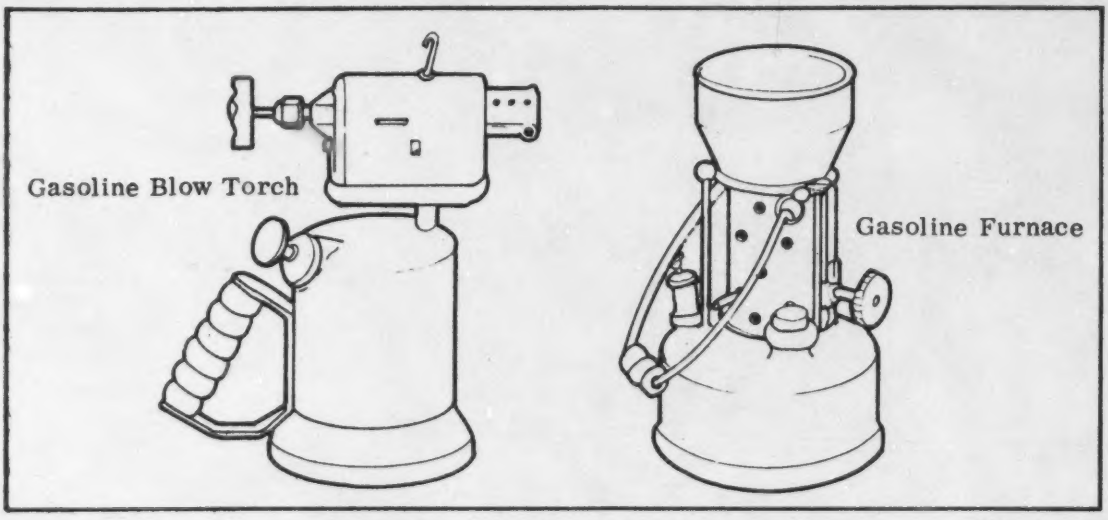
SOLDERING COPPER



The soldering copper may either be a square or octagonal shaped piece of copper with a point which is a tapered square or a wedge shape. They are usually purchased in pairs. One may be used while the second is heating. Coppers range in weight from ½ pound to 14 pounds per set. These soldering coppers must be heated from an outside source such as a propane torch, gasoline blow torch, or gasoline or gas fired furnace. Tips of coppers are cleaned and shaped with a file. All soldering tips must be tinned (coated with solder). The tinning makes the handling of solder easier.

TORCHES

The propane torch is a self contained heating unit. For larger soldering jobs it can be used directly, eliminating the soldering copper. However, it can be used to heat a soldering copper. It is clean to use, comparatively safe if used properly, and easy to store.



The gasoline blow torch and gasoline furnace must be operated with extreme care because there is considerable danger of an explosion, fire, or both. Gasoline is stored in the container under pressure from the pumps. These two heating units will furnish a very hot flame.

SIMPLE RECALL TEST
ON
SOLDERING EQUIPMENT AND SUPPLIES

Directions: Read each statement carefully. Select a word or words which will complete the statement correctly. Place your answer in the blank space to the right of each statement.

1. A flux must be used with ____ solder. _____

2. For small soldering jobs the ____ solder is preferred. _____

3. Solder is an alloy with a smaller percentage of lead which determines the ____ point. _____

4. The electric solder gun is very adaptable to electrical work and has the advantage of heating quickly which ____ the job. _____

5. One advantage of the electric soldering copper is that it holds a ____ heat. _____

6. All soldering tips must be tinned to make the handling of ____ easier. _____

7. Soldering copper tips may be tapered square in shape or ____ shaped. _____

8. Soldering coppers are purchased in ____. _____

9. The propane torch is a self contained ____. _____

10. If a very hot flame is needed, a ____ torch can be used. _____

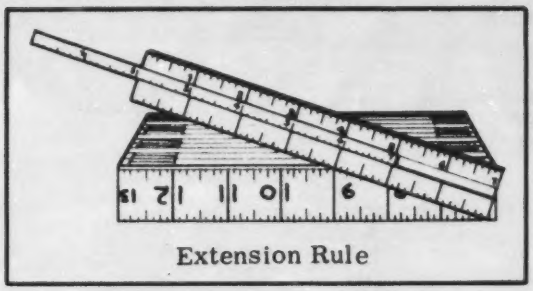
MEASURING TOOLS

The electrician uses measuring tools for lengths of wire, sizes of openings, lengths of conduit, and other measurements.

In laying out work accurately the electrician must first select the correct tool, second, use the tool correctly, and third, be able to read the measuring tool correctly.

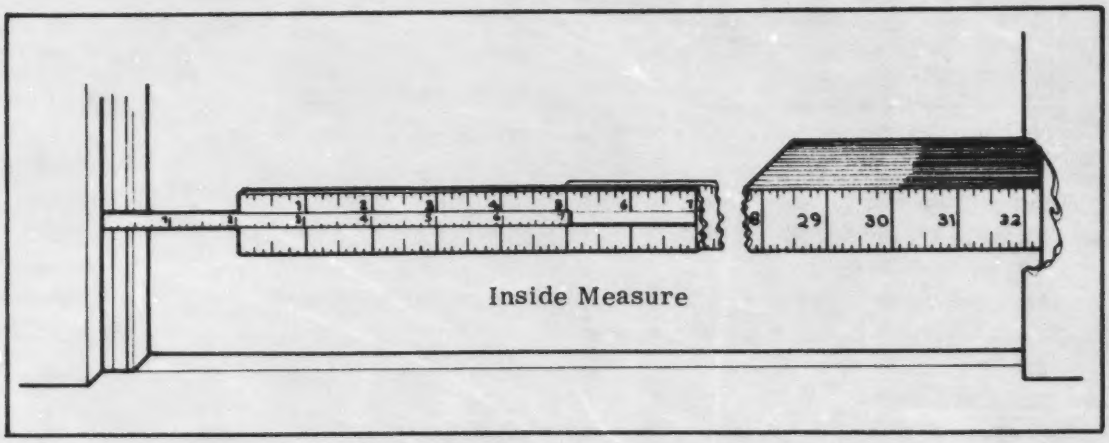
Measurements made by the electrician will vary according to the type job to be done. For long measurements the steel tape is used. Shorter measurements and openings are made with the push-pull tape rule or the folding extension rule. Regardless of the type rule they all have the same system of linear measure.

FOLDING EXTENSION RULE



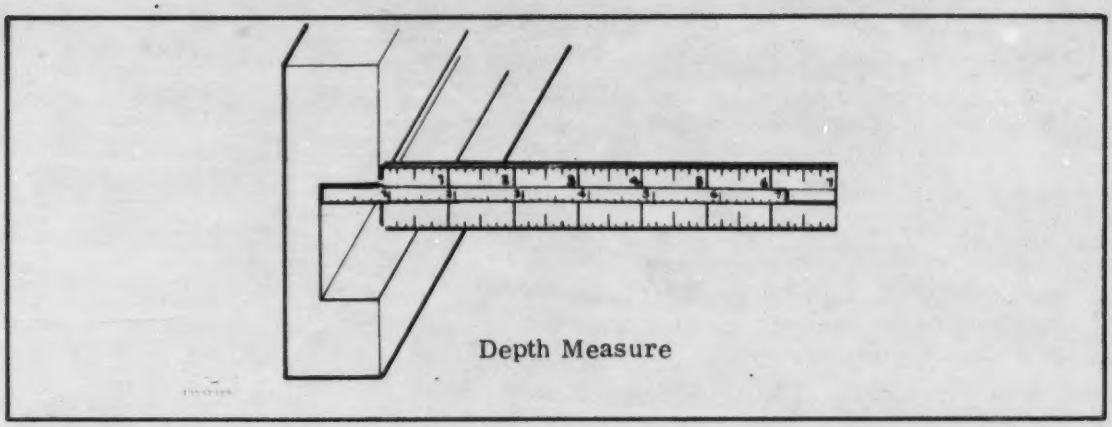
Extension Rule

The extension rule has a brass slide located in the first joint. The brass slide can be extended beyond the joint or removed from the joint. This is a zigzag folding type rule. It may be used to measure length, take inside measurements, or take depth measurements.



Inside Measure

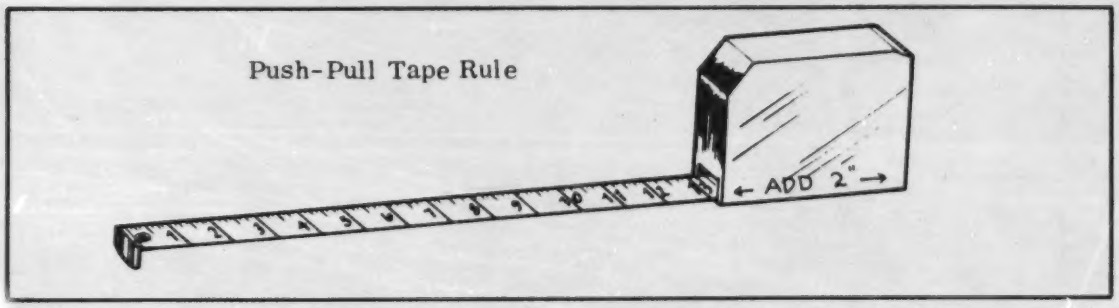
For inside measurements the graduations on the slide are added to the measurements on the rule.



Depth Measure

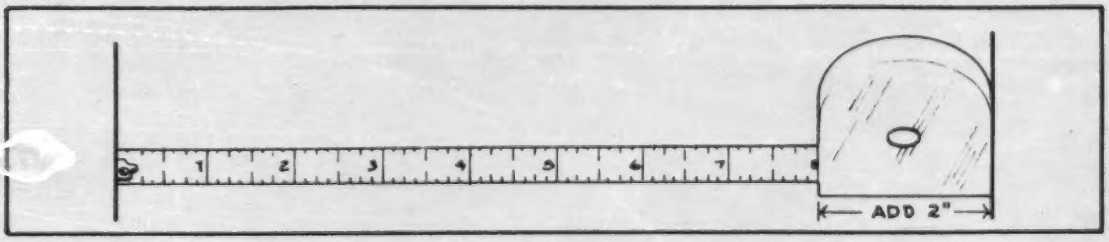
Depth measurements are taken directly from the slide. The end of the first joint acts as the stop, and it is at this point that the reading is taken.

POCKET OR PUSH-PULL TAPE RULE

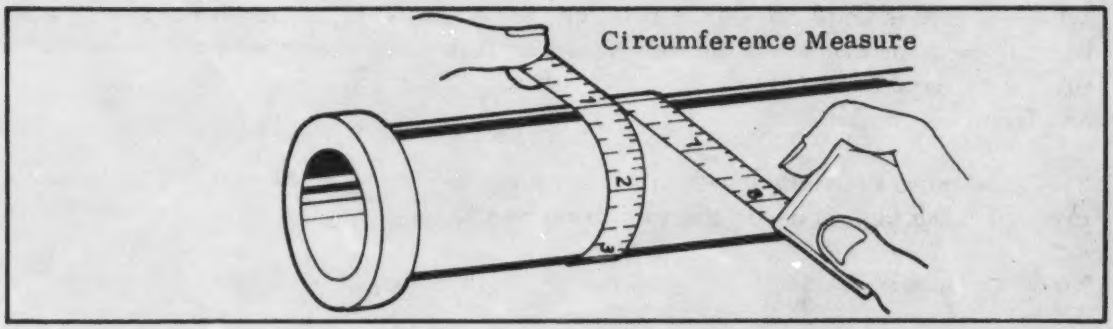


The push-pull rules are usually manufactured in lengths of from 6 feet to 20 feet. On the flat edge of the case there is an add inch. In the illustration, the add 2" means that the case is 2" long. For inside measurements, this 2" is added to the graduations indicated on the tape.

Graduations are printed on one side of the tape only. Usually the tape is graduated in 1/16" on both edges; however, some tapes may have the first few inches graduated in 1/32". The tape has a hook fitted to the end for ease of positioning and holding tape in place for a measurement.

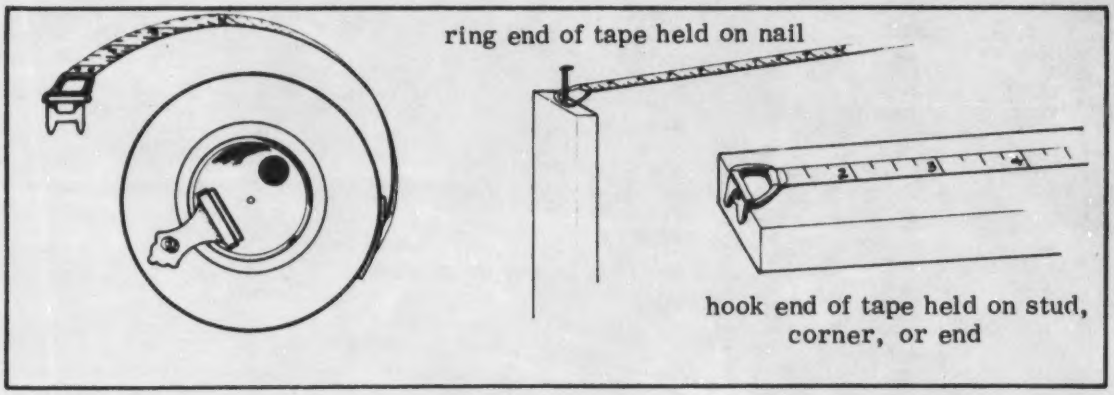


Add 2" of case length to tape measurement for inside measurement.



The tape is looped closely around the cylinder. Graduations are matched and the reading taken. In the illustration the one inch and the seven inch graduations match. To find the circumference of the cylinder, one inch must be subtracted; thus the cylinder has a six inch circumference.

STEEL TAPE



The steel tape can be used to measure lengths up to 200 feet. Different types of steel tapes are manufactured to meet special requirements. The flexible spring steel tape is stamped on one side in graduations of feet, inches, half inches, quarter inches, eighth inches, and some tapes will have sixteenth inches.

These tapes may have a ring or eye on the end or a hook. In some cases both will be present. The ring is used to hook over a nail to anchor the tape for measurements. The hook anchors a tape over the end of a board, side of a stud, or at a corner for measurement.

The tape case is usually round in shape. There is a winder on one side. The winder is hinged allowing it to be folded up flush with the case. The handle fits in a hole in the case, locking the winder in the closed position. To open the winder, simply push on the handle from the opposite side from the winder.

To uncoil the flexible steel ribbon from the case, pull it outward straight. It is not to be folded backward from the opening. This will damage the tape.

When the tape is unwound, do not twist or step on it. This can cause the tape to kink, become bent, or crack. If the tape sticks as it is being retrieved or extended, simply lay the case flat and tap it on a flat surface. This will even up the spirals of tape and free it.

The tape must be treated with oil at frequent intervals. The oiling should be increased if the tape is used in wet or damp weather.

To oil the tape:

1. Uncoil the tape - laying it out straight.
2. Dampen a lint free rag with oil.
3. Hold the oily rag around the tape.
4. Wind the tape into the case.

MATCHING TEST
ON
MEASURING TOOLS

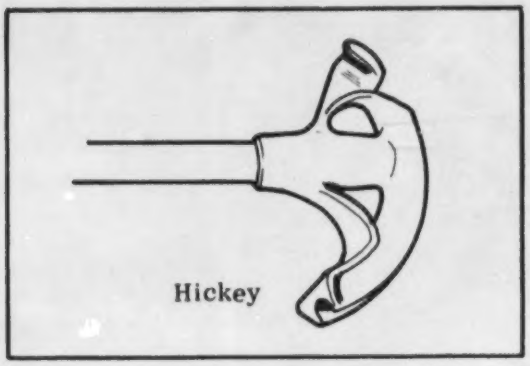
Directions: One item from column I is closely related to or associated with an item in column II. Place the capital letter of the associated term in column II in the blank space at the left of the number in column I.

Column I	Column II
____ 1. An accurate measurement of the depth of a hole.	A. Push-pull tape
____ 2. Must be oiled.	B. Extension rule
____ 3. The circumference of a cylinder.	C. Ring
____ 4. Zigzag folding.	D. Measuring tools
____ 5. Vary according to type job to be done.	E. Free tape
____ 6. Used to find lengths and depths of holes.	F. Graduations
____ 7. Printed on one side of the tape only.	G. Steel tape
____ 8. Anchors tape for measurement.	H. Uncoil
____ 9. Tap case on flat surface.	I. Brass slide
____10. Pull tape straight from case.	J. Measurements

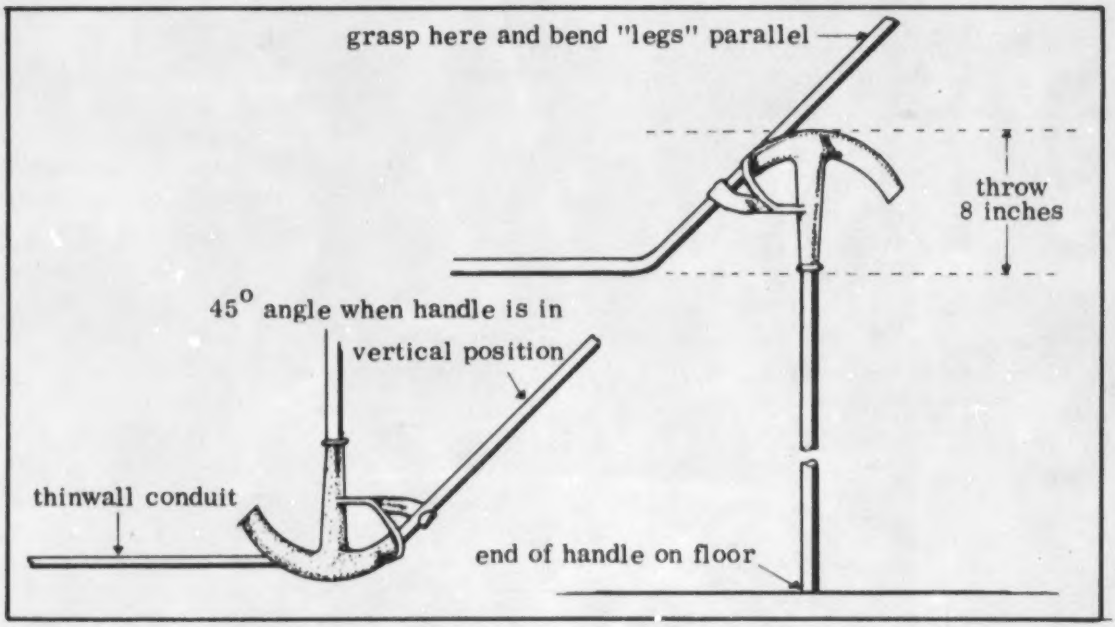
CONDUIT AND PIPE TOOLS

Other tools used for conduit and pipe which will not be shown here are taps and dies, bench or hydraulic benders, wrenches, pipe vise, etc.

CONDUIT BENDER



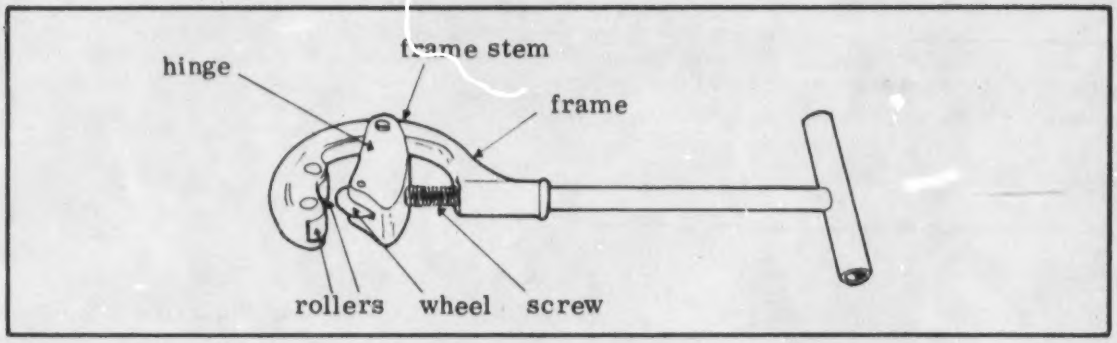
There are three types of hand hickeys (conduit benders), one for rigid conduit, one with a flanged socket for thin-wall conduit, and the one illustrated here is also the thin-wall conduit. This conduit bender is the type most commonly used.



Bends are made by holding conduit in a fixed position and moving the hickey; also, bends are made by holding the hickey in a fixed position and shaping the conduit to the hickey.

Any type bend can be made such as an offset, saddle, right-angle, etc.

PIPE CUTTER



The pipe cutter illustrated here is of the wheel and roller hinged type. Most pipe cutters have a hook shaped frame on whose stem either a hinge or slide is moved by a screw. Rollers and wheel may be mounted on the frame or on the movable part. The wheel is forced into the pipe as the tool is rotated around the pipe.

The pipe cutter as illustrated can be converted to a three-wheel cutter by replacing the rollers with cutter wheels.

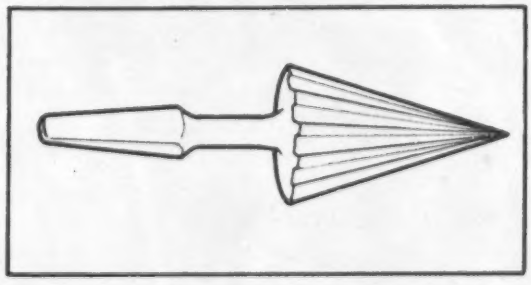
Pipe is cut quicker and with more accuracy than with a hacksaw, even though the hacksaw leaves less burr. Therefore, for the sake of speed and accuracy the pipe cutter is used for most jobs.

Three-wheel cutter:

1. Somewhat more difficult to start than wheel and roller cutter to make sure the cut is straight.
2. It leaves more of an outside burr. Burr must be filed off before attempting to thread the pipe.
3. Has the advantage of being able to cut a pipe in a close place. Handle need move only 120^{O} in order to part the pipe.

Cutter wheels are easily removed and replaced when they become dull or nicked.

PIPE REAMER



Different types of tapered reamers are available. Their primary use is to remove burrs from the inside diameter of a pipe; however, they can be used for countersinking and enlarging holes in sheetmetal.

Some are adaptable for use in a brace, others with a ratchet, and some with an electric drill.

Burrs must be removed from pipe and conduit because:

1. Inside burrs make it difficult to pull circuit wires.
2. Outside burrs make it difficult to thread pipe or conduit.

ESSAY TEST
ON
CONDUIT AND PIPE TOOLS

Directions: Below are questions that are to be answered in complete sentences and in as few words as possible. The test is designed to include correct spelling and the use of correct trade terms.

1. What are two ways that a conduit bender is used to shape and form conduit bends?

2. What are the type bends made with a hickey?

3. What are two disadvantages of a three-wheel pipe cutter?

4. What is an advantage of the three-wheel pipe cutter?

5. Why use a pipe cutter as opposed to a hacksaw?

6. What causes the pipe cutter to part pipe?

7. Why remove burrs from pipe or conduit?

8. What are the uses for a pipe reamer?

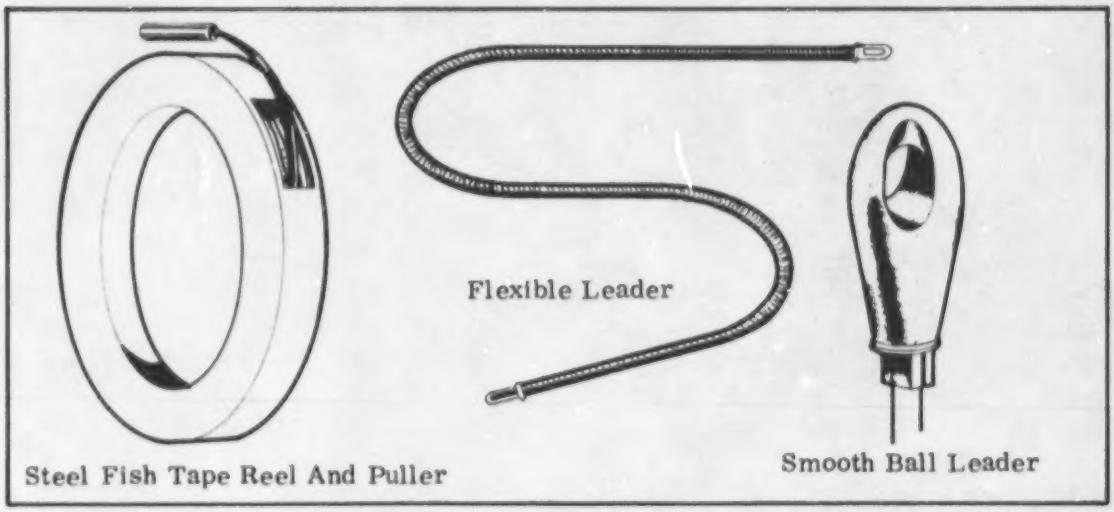
9. What is the shape of a pipe reamer?

10. What are the ways in which pipe reamers are adaptable for use?

FISHING TOOLS AND MATERIALS

With conduit and various outlet boxes installed and other roughing in completed, the electrician is ready to pull wires in for the different circuits.

FISH TAPE



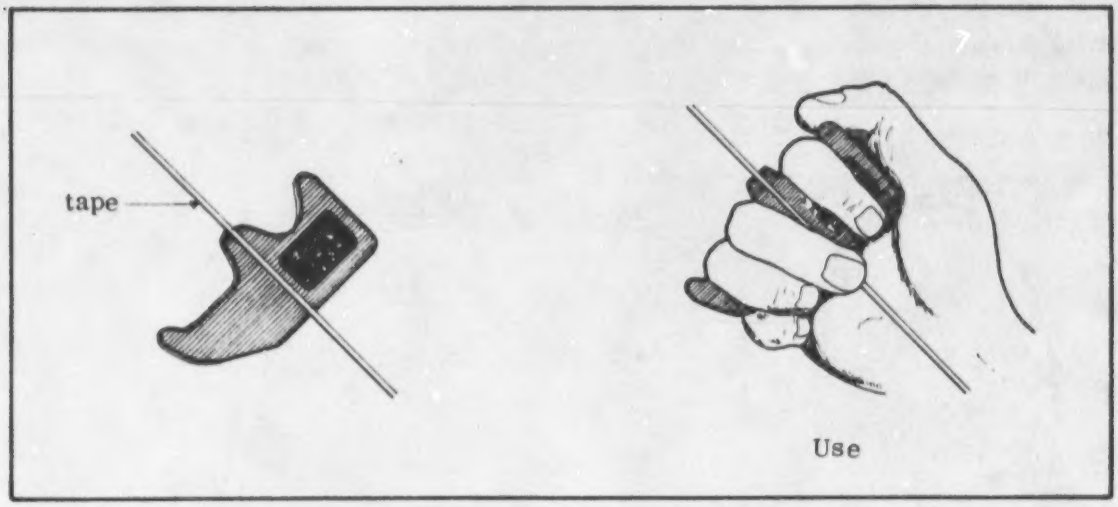
The fish tape is used to pull wires through conduit of new construction and through wall or ceiling openings in reconditioning or add-on for older structures.

Fish tape is a flat piece of tempered steel in lengths of 50', 100', and 200'. The tape is coiled into a reel which prevents it from twisting and tangling. Fish tape is manufactured in three thicknesses: .030", .045"., and .060". Manufactured widths are 1/8", 3/16", and 1/4". The most used tape has a thickness of .060" and a width of 1/8"; this is the most sturdy and will withstand a heavy pull.

If the tape does not have an attached leader, there are two that may be used. One leader is known as a flexible terminal strip (flexible leader) and the other is a smooth ball type. Each is slotted to slip over the tape and clamped in place. Either one makes fishing a much easier task by doing away with the trial-and-error method of pushing a tape through a difficult conduit run.

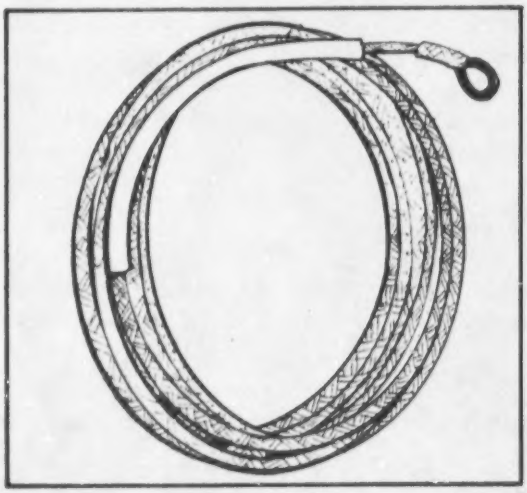
When a tape has been fed through a run of conduit, wires are fastened through the eye of the leader and pulled out the other end.

PULLER



In some cases the pulling process requires a rather heavy pull; therefore, to make it easier some form of puller handle is used. Some tape reels have a locking device to make the tape stationary and the reel is used as a puller. The illustration shows another type puller. It is slotted to slip over the tape. With pressure applied by the grip of the hand the puller binds the tape and pulling can be done. Take care not to rock the hand back or forward as it may kink the tape.

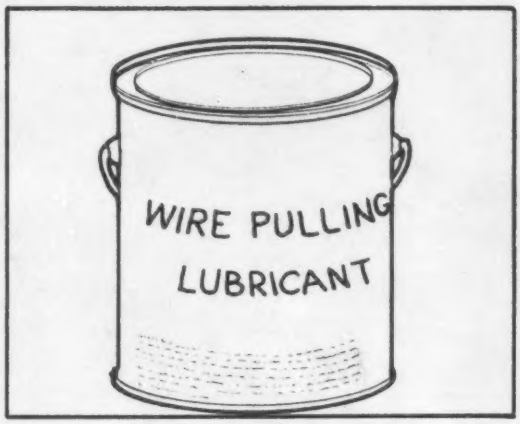
FLEX FISH TAPE



This may be made of braided polyethylene or spiral-wound, multi-layer flexible steel cable. They are approximately 3/16" in diameter and are available in lengths of 25', 35', 50', 75', and 100'. This type of tape comes equipped with large eye loops in each end. The best of these tools will withstand a pull of about 500 lbs. They will pull wire through all types of conduit: aluminum, plastic, and flex. They are reported to be easier to push through tight twists and turns than flat tape. They may be used as leaders for flat tapes.

WIRE PULLING LUBRICANT

When conduit construction is long, complicated with bends or tight twists and turns which cause conductors to bind or stick, the conductors are coated with a pulling lubricant. Lubricants are non-corrosive substances with a lack of moisture, oils, and the like. Wire pulling lubricants may be talc, soapstone, flax soap, or a combination thereof. Lubricant is applied to the wires as they enter the far end of a run.



ESSAY TEST
ON
FISHING TOOLS AND MATERIALS

Directions: Below are questions that are to be answered in complete sentences and in as few words as possible. The test is designed to include correct spelling and the use of correct trade terms.

1. What are two uses for which fish tape is used?

2. What is the most used size fish tape?

3. What devices are used to help fish steel to pass around bends in a run of conduit?

4. What means are used to pull a tape after it has been fed through a conduit run?

5. What are two types of flex fish tape?

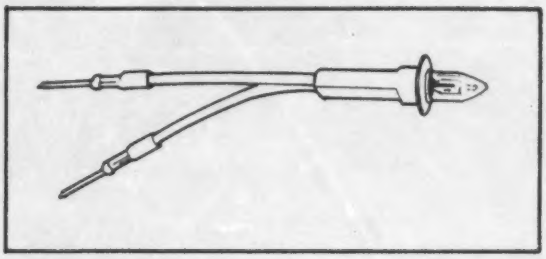
6. How are the ends of a flex fish tape equipped?

7. What is a second use for a flex fish tape?

8. What action is taken if wires being pulled bind or stick?

9. What are some of the lubricants used to assist with a pull?

TEST LIGHT

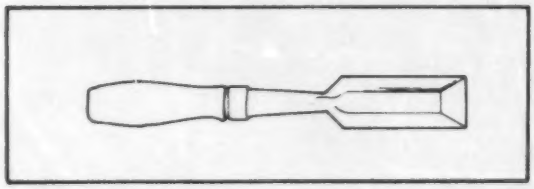


This electrician tool is used to determine if a circuit is hot. It may also be referred to as a neon tester.

Any circuit that is about to be worked on must be considered a live one. This is when the test light is used as a safety device to prove to one's self the status of a circuit. The probes are inserted into a receptacle to see whether or not electricity is present. Some receptacles are split wired on separate circuits; therefore, test both receptacles. If power is present remove fuses or flip circuit breakers to the off position until the light goes out.

The test light is tested by inserting the probes into a known live circuit to make sure the light will burn.

WOOD CHISEL



The wood chisel is used to notch out wood framing structure or to remove small wood obstructions.

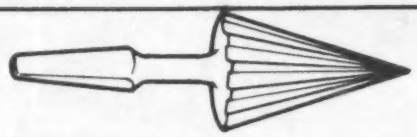
Wood chisels are made of tough alloy steel blades with precision-ground bevels and cutting edges. They are of a one-piece blade and tang. Handles are usually made of plastic with a rounded steel end cap for hammering.

Blades are manufactured in widths of $\frac{1}{4}$" to $1\frac{1}{2}$". Overall length varies from $7\frac{1}{4}$" to $8\frac{1}{4}$".

This tool should be kept sharp and ready for use. When using this tool, care should be taken not to strike nails or other metal objects with the cutting edge.

FINAL EXAM
PICTORIAL RECALL TEST
ON
RESIDENTIAL WIRING TOOLS

Directions: Identify each of the tools as illustrated below. Write in their full correct names in the numbered blanks below each tool.



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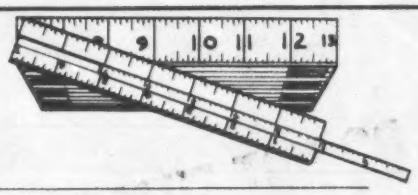
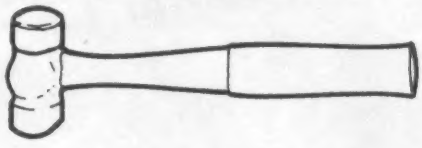


7. _____

2. _____



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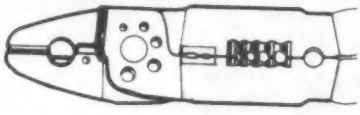
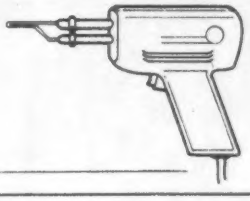


3. _____

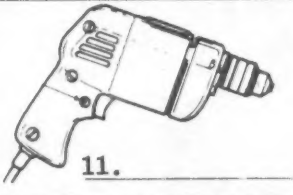


9. _____

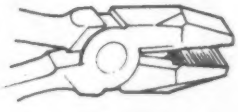
4. _____

10. _____

5. _____



11. _____



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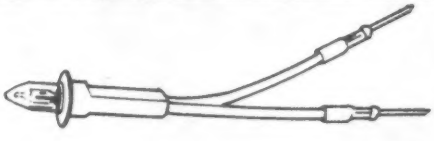

12. _____